Municipal Debt Finance and Mutualisation

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of the Degree of Doctor of Philosophy

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Abstract

The local authority credit market is an important source of funding, matching long-term financing to infrastructure investment programmes. This study considers the financial innovation of developed-market subnational governments, when raising private funds via bond mutualisation, to understand if it improves municipal bond market efficiency. The thesis compares three important alternative means for raising long-term debt, namely direct government-backed lending; individual bond issues; and municipal credit-pooling agency backed bond issues. It addresses clear gaps in the existing European municipal bond agencies (MBAs) literature — only one other paper is relevant to Chapter 1 and none on MBAs are relevant to Chapter 3. The database of Chapter 2 is substantially more detailed than any in the literature and so provides an insightful empirical output.

Chapter 1 addresses whether European MBAs offer subnational governments (SNGs) a viable alternative to central government debt. I show that a credit-pooling agency can issue domestic bonds at a competitive yield that enables it to offer loans to SNGs more cheaply than if they were to borrow directly from a central government agency. The thesis is motivated by the launch of the UK Municipal Bond Agency. Following a counter-factual that a synthetic UK MBA, credit-ranked pari passu with the European MBAs, issues bonds in public markets and distributes loans to its members, I show that local authorities could save interest costs relative to their existing borrowing. Chapter 2 finds that credit rating and the required size of credit determine whether a US municipality issues its own bonds or participates in a credit-pooling agency's issuing activity. I estimate interest cost savings relative to issuing its own bonds for a participant in a municipal bond bank's bond issuance. Chapter 3 investigates whether the MBAs take advantage of the failure of Covered Interest Parity (CIP), so that their bond issuance in foreign currencies reduces their interest costs. I estimate that MBAs achieved average interest cost savings of between 20.4 and 23.8 bps when issuing foreign currency bonds, relative to issuing in their respective domestic currencies over 2009-16. However, I find limited evidence that the MBAs are sensitive to deviations from CIP in timing bond issues.

Issuing bonds based on a joint and several guarantee, MBAs operate through a coinsurance design, whereby financially stronger SNGs subsidise weaker ones. They indirectly leverage on their country's borrowing capacity, so they require supportive institutions including a highly credit-rated national government, a legal system that allows interventions if an SNG falls into financial distress, and prudent borrowing by subnational governments. Most importantly, they require the collective buy-in of a peer group that wishes to use this agency to reduce the cost of borrowing for the common good. UK local authorities seem to be reluctant to provide a joint and several guarantee for their liabilities and, therefore, the original MBA model fails. Differences in the UK from the collectivist culture of the Dutch and Nordic MBAs hamper local authority buy-in to a business model that has proved successful elsewhere.

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INTRODUCTION

Abstract

Public finance is central to most economies around the world. In this thesis, I address a part of the market that has received little academic attention, namely how does the credit-pooling of bond issues contribute to the long-term funding of subnational governments (SNGs)? In the forthcoming chapters, I study the role of European municipal bond agencies and US municipal bond banks to explore whether they save interest costs for their members, relative to other means of long-term SNG finance. In this Introduction, the tradable bond market for the credit-pooling municipal bond agencies is described. It represents approximately 9% of all outstanding municipal bonds globally and is concentrated within a dozen countries.

Keywords: Municipal bond agency; municipal bond bank; joint and several guarantee

JEL Classification Numbers: G12, G21, H74

SUBNATIONAL GOVERNMENTS AND MUNICIPALITIES

Global subnational [1] government bond issuance represents approximately US$700 billion per annum [2] or 11% of all OECD bond issuance. Yet numerous papers discuss the lack of liquidity and price efficiency within these markets [3]. This study considers how credit-pooling contributes to improving the long-term funding of SNGs to support their capital investment programmes. In particular, it examines the mutualisation of municipal bond markets in developed countries through credit-pooling bond-issuing agencies, such as Municipal Bond Agencies (MBAs) and Municipal Bond Banks (MBBs). This Introduction describes the context for my research questions by describing the funding of SNGs' capital investment around the world.

The World Bank defines Subnational Governments as 'all tiers of government and public entities below the Federal, or central, government…that have the capacity to incur debt.' An SNG is a decentralised entity with responsibilities and some autonomy for budget, staff and assets. It can raise taxation locally and usually holds local elections for its governance bodies; it expresses territorial identity through local government; and it uses public resources through local bureaucracy and legislative powers. The Organisation for Economic Co-operation and Development (OECD) defines three tiers of SNG in a sample of 122 countries, representing 89% of global GDP (OECD/UCLG, 2019), as follows:

1. 624,166 municipality-level governments;
2. 11,965 intermediate-level governments (e.g. counties, prefectures, regions);
3. 1,769 state governments (e.g. States, Länder within federations).

Municipalities represent the most local level of the SNG structure. Of the above countries, 36 have a single municipal level, 59 have municipal and regional levels and 27 have all three levels of subnational government. Examples of countries with three levels include the UK, US and France. SNG aggregate data at the OECD level is summarised below.

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[1] USAID (2009) defines a subnational body as any administrative entity below the national government or sovereign level. A municipal bond can be issued by a subnational government or local administrative entity. Throughout the thesis, I use municipal bond as a synonym for subnational bond.

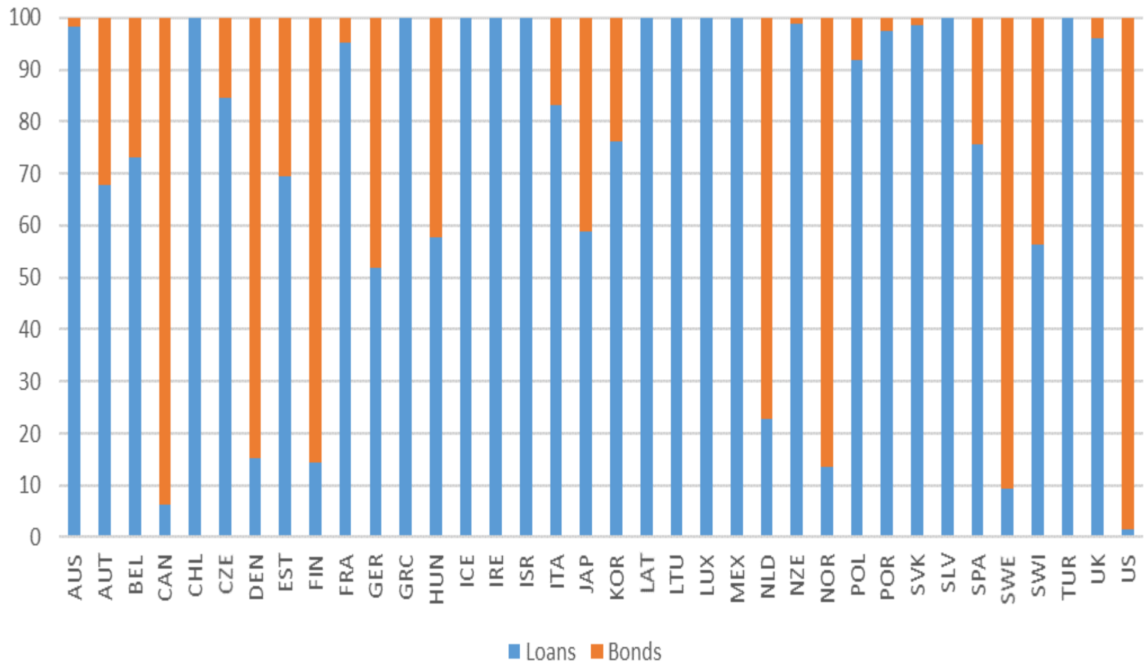
[2] This excludes data on China, which are not recorded in government accounts. Their total amount differs, according to reputable sources, and is not released on a regular basis.

[3] Refer to the literature review

Subnational spending and funding

The OECD estimates that total SNG capital expenditure in its sample was approximately US$1.7 trillion in 2017 (OECD/UCLG, 2019). These programmes represent 22% of total SNG annual expenditure and are funded by long-term debt, primarily through borrowing from central government, municipal development funds or banks and bond issuance. At the end of 2013, outstanding SNG gross debt of approximately US$7 trillion accounted for 14% of gross government debt or 9% of the total GDP of its sample (OECD/UCLG, 2016). In many developing countries, subnational debt is constrained by central government control. These countries rely more upon loans and transfers from central government, banks and funding agencies. However, bond issuance is popular in developed countries, as shown in Figure 1. Of the 35 member countries of the OECD, bond financing represents at least 30% of outstanding SNG financial debt in 13 countries.

Figure 1: The Split of SNG Financial Debt of OECD Members



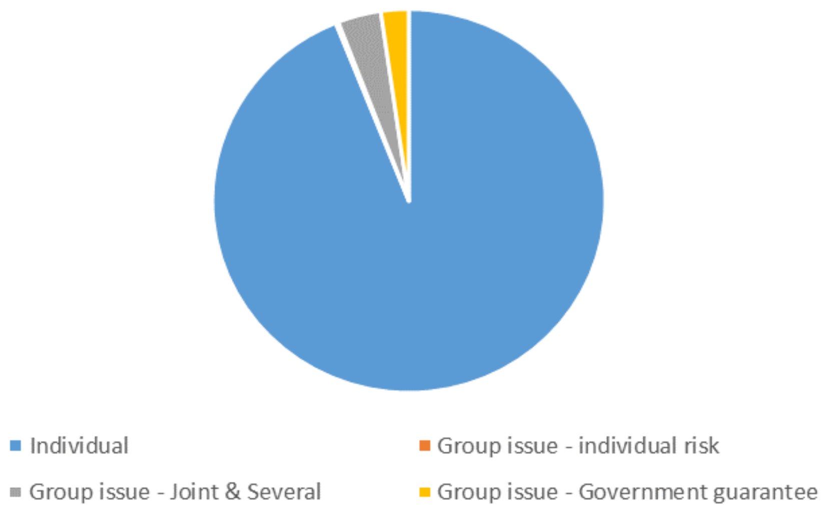
Source: OECD and national data; calculated

Bond funding is undertaken as follows:

1. Issue general obligation or revenue bonds as an individual SNG
2. Issue bonds as a group, while bearing individual risk
3. Issue bonds as a group through a bond agency, with joint and several guarantee of pool members
4. Issue bonds as a group through a bond agency, with government guarantee

The first method represents the vast majority of global municipal bond issuance. However, this does not address mutualisation of bond issues. This thesis studies methods 2, 3 and 4. It investigates whether these relatively small markets offer interest cost savings to participants, improve market efficiency and have potential to grow. Issuing bonds as a group with individual risk is only undertaken in the US. This process is described in detail on pages 84-85 in Chapter 2. Methods 3 and 4 are relevant to the discussion of Chapter 1 and are compared in more detail on pages 39-40.

Figure 2: Share of Outstanding Municipal Bonds by Type



Source: OECD, national sources

Two methods of individual bond issuance are common. A general obligation bond is backed by the credit rating and taxing authority of the issuer and bond holders are dependent upon its good reputation and track record. This differs from the backing of a revenue bond, which depends on the success of the specific project it is issued to fund.

Examples of issuing bonds as a group, while bearing individual risk, include municipal bond banks and municipal finance agencies. This structure exists only in the US. The aggregated proceeds of pooled bond issues are used to purchase the general obligation bonds of participants. Their credit strength rests in a reserve fund that accrues by over-issuing pooled bonds by up to 10%, relative to the aggregate demand of municipalities, and an implicit guarantee — normally a moral obligation by their respective State — to back all issues in their pools in the event of default by any local issuer. Moody's normally values the State obligation in isolation with a one-to-two notch discount relative to an MBB's respective State credit rating.

Issuing bonds with joint and several guarantee underlies the new UK and French credit-pooling agency business models, akin to existing MBAs in Denmark, Finland, Sweden, Japan, Canada and New Zealand. The joint and several guarantee of its members enables an MBA's risk to be equated with that of its guarantor or liable institution by the credit rating agencies. Each of the MBAs has processes that relate to individual members in distress. If a liability event occurs, creditors can demand full satisfaction of the claim from all guarantors, even if they only approach one of them. Each member guarantees the entirety of the agency's liabilities, with internal processes to share the burden of a claim.

Examples of issuing bonds with an implicit government bond guarantee include the activities of KBN in Norway, BNG and NWB in the Netherlands. KBN and BNG are owned by their respective central governments and NWB is partly owned by the Kingdom of the Netherlands. Its status as a government-related entity implies an implicit government guarantee of liabilities. While no formal government guarantees exist for these three agencies, their roles in the Dutch and Norwegian public sectors imply a high probability of government support if needed.

The major municipal bond markets

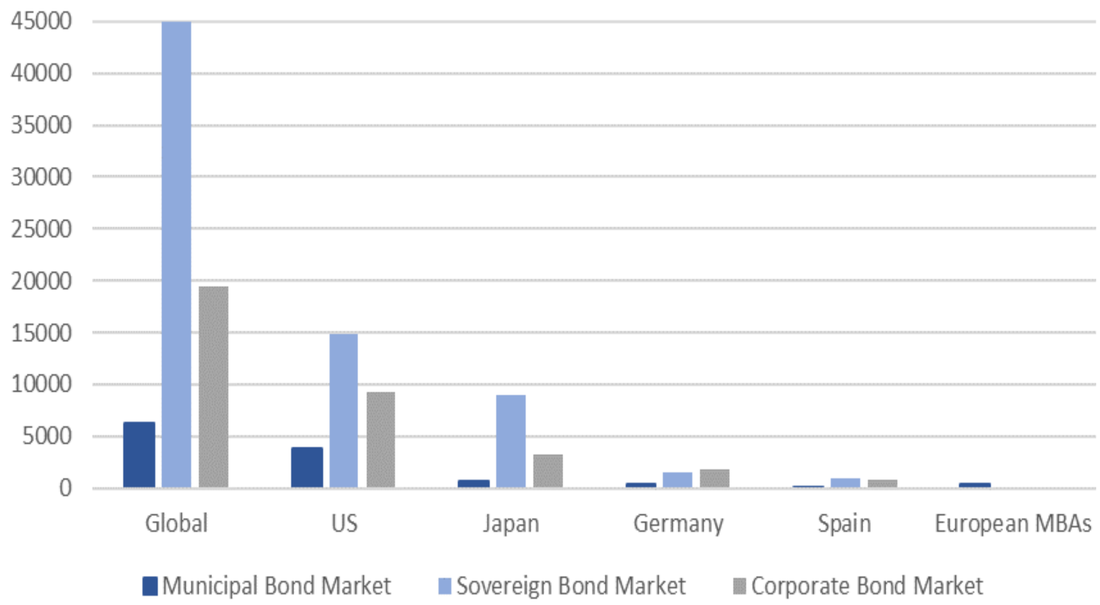
The US, Japanese and German markets and the European MBAs represent over 80% of the total annual OECD member issuance of municipal bonds [4]. Several smaller countries are restricted by laws on municipal bond issuing and have strict prudential fiscal rules defined by their respective central governments. The US is the most mature market with a value of bonds outstanding of US$3.8 trillion at the end of 2018, according to the Municipal Securities Rulemaking Board (MSRB). Of US SNG debt, 95% is represented by bonds across municipality, county and State levels. As a comparison, this is approximately 26% of the size of the US Treasury market and 41% of the US corporate bond market, according to the Bank of International Settlements (BIS). US municipal bond issuance totalled US$390 billion in 2018, according to the MSRB.

The Japanese Ministry of Finance estimates total outstanding subnational government bonds in Japan at US$649 billion at the end of 2016 (at two levels – municipalities and prefectures). This is approximately 7% of the size of the local sovereign bond market and 20% of the corporate bond market, according to the BIS. In 2017, a total of US$58 billion of municipal bonds were issued, according to the Japan Securities Dealers Association.

[4] China's municipal bond market has also grown significantly. According to the Chinese Finance Ministry, total SNG debt was 16.5 trillion yuan (US$2.4 trillion) at the end of 2017, 88% of which is held in the form of bonds. The majority of this is the result of Local Government Financing Vehicles swapping debt into bonds since 2015, to reduce outstanding debt below the 21 trillion yuan debt ceiling set for subnational government by the National People's Congress.

The German SNG bond market was estimated to be worth US$364 billion at the end of 2018 by the Federal Republic of Germany Finance Agency (at two levels – municipalities and Länder). By comparison, this is approximately 24% of the size of the local sovereign bond market and 20% of the corporate bond market, according to the BIS. However, borrowing from public sector banks remains the most common means of long-term funding for individual German SNGs. Other countries with a high value of outstanding municipal bonds include Spain (US$67 billion – municipalities and regions), Canada (US$40 billion – municipalities and provinces/territories), Italy (US$23 billion – municipalities and regions) and France (US$18 billion – municipalities and regions) (ref: OECD, 2019).

Figure 3: Outstanding Bond Totals of the Largest Municipal Bond Markets



Source: BIS, Standard & Poors, SIMFA (global totals exclude China); the y-axis is measured in US$billion; data at end 2018 except Japan municipal bonds, which is 2016.

Municipal credit-pooling agencies

Twelve developed countries have created municipal credit-pooling agencies over time. I estimate that the outstanding global municipal bond agency tradable bond market was worth approximately US$540 billion at the end of 2018. This represents over 9% of the global total of issued municipal bonds. Japan, the Netherlands and the Nordic countries combined represent over 90% of this by size. The largest municipal bond agency in the world is the Japan Finance Organization for Municipalities (JFM). At March 2019, it had outstanding bonds worth US$190 billion, according to JFM data. It is wholly owned by Japanese SNGs and its participants provide a joint and several guarantee of its bonds. It is rated A+ by Standard & Poor's and A1 by Moody's, which is in-line with the Japanese sovereign ratings.

Pooling of credit has the broadest traction within Western Europe. The European municipal bond agency market had a combined gross total of bonds outstanding of US$320 billion and annual bond issuance of US$78 billion in 2018. The two Dutch agencies represent 51% of outstanding European MBA funding. Each MBA (excluding Agence France Locale) represents the majority of municipal bonds outstanding in the five countries where they are active. The credit ratings of all European MBAs (excluding Agence France Locale) are in-line with those of their respective sovereign and there is no record to date of a credit default event.

Table 1: Outstanding Funding and Lending of the European MBA Issuers

	Method of Guarantee/Support	Funding (€ billion)	Lending (€ billion)
BNG	Implicit government	89.5	80.8
NWB	Implicit government	56.8	47.6
KBN	Implicit government	41.9	30.6
Kommuninvest	Joint and several	38.8	34.8
Kommunekredit	Joint and several	27.9	22.8
MuniFin	Joint and several	26.9	23.0
Agence France Locale	Joint and several	3.0	2.2
		284.8	241.8

Source: The agencies' report & accounts, 2018 in euros

Other MBAs include seven Canadian Municipal Finance Authorities, which had a combined US$19 billion of bonds outstanding at end 2017, all of which are underwritten by the joint and several guarantee of their participants. The New Zealand Local Government Funding Agency was founded in 2009 and represents 59 councils. It is growing steadily in terms of market share, with US$5.3 billion of bonds outstanding at the end of 2018. Bond issues are supported by a joint and several guarantee from participating local authorities and a US$500 million liquidity facility from central government. Its bonds are rated at AA+ by Standard & Poor's, in-line with the New Zealand sovereign rating. There are small MBAs in Iceland and Australia.

Field of the thesis

Chapters 1 and 3, focus on the bond issuance of the six largest European MBAs. All of these agencies issue bonds for members at two subnational levels (municipality and the higher regional/county-level). In Chapter 2, the US MBBs provide bond funding at the municipality-level only. Their combined long-term bond liabilities total US$20 billion, representing 0.5% of the US municipal bond market.

ECONOMIC ISSUES

This section reviews the main issues discussed in the literature, before drawing out the specific research questions raised in this thesis. With an overview of the economics of the contracting environment, I outline potential frictions within SNG finance, how these might impede SNGs from raising capital and how financing mechanisms (e.g. credit-pooling agencies in Chapters 1 and 2 and foreign currency bond issuance in Chapter 3) address them and enhance access to credit. Chapters 1 and 2 investigate whether private capital markets improve liquidity, information and monitoring, relative to government agency lending and individual municipal bond issuance respectively. However, these markets might introduce frictions of their own that affect the contracting landscape. A different set of frictions causes the failure of the Covered Interest Parity condition for foreign currency bond issuance. This is discussed in detail in Chapter 3 to avoid duplication here. All frictions are discussed in more detail within the relevant chapters.

Literature review

Relevant European literature on municipal bonds and pricing the bond yields is scarce. Indeed, the most recent published paper on a European MBA (Schnitzler, 2017) does not include a single literature reference to a European paper. However, a body of work covers the US municipal bond market. While threads of such research are relevant to this thesis, the business model in the US is different from that of the European markets. For example, 50,000 issuers and one million municipal bonds are outstanding in the US municipal bond market, which contrasts with a much smaller number of regional and municipal bond issuers and nine European credit-pooling municipal bond agency issuers. Peterson (2003) offers a comparative study of US and Western European subnational credit markets.

Municipal bonds differ from sovereign bonds in two important features: they have higher default risk and they are less liquid, in part because information in the market is limited, decentralised, and non-standardised. Drawing on the US literature, the lack of liquidity in individual municipal bond markets is summarised and a number of secondary market frictions identified. Against this, some of the features of municipal bond agencies and their bond characteristics, such as the joint and several guarantee, are highlighted.

Liquidity frictions and bond transaction costs

Liquidity has been poor and transaction costs high in the markets for individual municipal bonds for many years, predating the Global Financial Crisis (GFC). These affect the costs of issuance. Direct costs to issuers include the fees paid to bond underwriters and any difference between the reoffering price and the price at which bonds are sold to final investors. Such transaction costs represent a large proportion of a bond's first year's yield. There are also indirect costs, such as the price concessions that are made to investors, who know illiquid bonds may be difficult to sell in the future. The MSRB states that nearly 67% of US municipal bonds are held by individual investors, either directly or through mutual funds. In a market that is dominated by small-sized transactions, Hong and Warga (2004) find that most US municipal bonds trade less than once per week and bid-offer spreads for retail-sized trades average over 2% of price for both rated and non-rated issues. Green et al. (2006) argue that the market for US municipal bonds exhibits high levels of price dispersion, even for similar trade sizes. Harris and Piwowar (2006) show that the average municipal bond traded just 15 times in total over its life. It is not until the 99.9^{th} percentile of their sample that they find municipal bonds that trade up to six times per day. They demonstrate high dealer mark-ups and transaction costs and a lack of investor transparency. Transaction costs decrease with trade size and liquidity increases with credit quality and decreases with investment complexity, time to maturity and time since issue. Trading spreads average 2% for US$20,000 trades, falling to 1% for US$200,000 trades. Marlowe (2013) also records a lack of liquidity in the US municipal bond market and claims that 10-20% of the municipal bond yield spread is attributable to liquidity risk.

Ang and Green (2013) show that the costs of trading US municipal bonds for retail investors are more than double institutional levels and double the costs of trading corporate bonds. Round-trip costs for a retail investor buying and selling a bond are in a 2-5% range. A typical municipal bond trades just twice a year, due to trading costs and the heterogeneity of the bond issues. Access to information in municipal bond markets and liquidity in trading involve externalities and other forms of market failure, such as a lack of standardisation and dissemination of financial information, which hinders comparisons across different bonds; the cost of information search; and bond complexity (e.g. bundling into derivative products) that reduces market competition.

Information asymmetry frictions

Municipal bond prices may take days to respond to changes in market information, interest rate movements or macroeconomic announcements. The absence of timely financial information about a borrower adds adverse selection risk. Investors must be concerned not just about the risk of the underlying credit, but also that the seller has private information. They pay less for investments that carry non-transparent risks and may demand more advantageous prices to overcome these risks, further raising costs to the bond issuer. Green et al. (2007) argue that limited transparency in the US municipal bond market renders slow price discovery and benefits to intermediaries from the search costs imposed on investors.

The US municipal bond issuers are a large and diverse group. This heterogeneity limits information flow, because of the fixed costs of gathering information, and inhibits liquidity by reducing the probability of a coincidence of needs between buyer and seller at any time. Municipal bond investors lack access to uniform standards of information disclosure and flow. Government accounting standards provide less transparency than their corporate counterparts, and compliance requirements vary by State. Financial reports from SNGs may be released with lags after the close of their fiscal years and are rarely available in a format that can be easily compared across SNGs and time. The lack of a central source of information on the financial situation of individual issuers, the costs of attached derivatives, fees in debt issues and net issuing costs make it difficult for individual investors to make well-informed investment decisions. Furthermore, when SNGs negotiate with financial intermediaries to issue debt, they often have less expertise and relatively few resources to guide their decision-making. This is detrimental not only to investors, but also to the SNGs.

Demand-side heterogeneity frictions

Different investor types respond differently to market shocks, according to their respective long-term motivations. Open-ended investment funds, in particular, are vulnerable to volatile short-term investor inflows and outflows, which can lead to 'gating' or suspension of fund trading and revaluations of a fund's investment holdings in extreme circumstances. The 2019 suspension of the LF Woodford Equity Income Fund is a recent example in the equity world. In the corporate bond literature, Manconi et al. (2012) show that forced sales of bonds by open-ended funds, facing investor redemptions, and insurers, facing regulatory solvency constraints, spread bond market contagion during the GFC, while dealers offered limited market liquidity, due to defined minimum leverage ratios. Timmer (2018) shows that mutual funds and banks buy debt securities pro-cyclically and long-term investors behave counter-cyclically. Goldberg and Nozawa (2018) argue that shocks in liquidity demand are associated with mutual fund flows. Once again, new banking regulations play a role in these markets: tighter regulation now hampers dealers' ability to use their balance sheets to absorb short-term order imbalances. This is echoed by Baranova et al. (2019), who observe that dealers, mutual funds and institutional investors in the UK corporate bond market have different motivations to trade. They amplify shocks to bond price falls in response to credit risk and risk-free rate shocks, which depend on agents' proximity to regulatory constraints and incentives. As prices fall, some agents may be forced to sell financial assets, so as not to breach constraints. On the other hand, dealers have limited capacity to absorb the sales.

Tax-driven heterogeneity frictions

Asset ownership decisions are significantly influenced by investors' tax rates and tax policy, at least in the US. As an example, heterogeneity in the taxation of asset returns can create ownership clienteles for municipal bonds. Babina et al. (2017) show that tax-induced ownership segmentation limits risk-sharing. The constraints of the ownership clientele impact the asset price response to variations in asset supply, and make the price more sensitive to movements in idiosyncratic risk. Cross-State variation in local tax rates results in different levels of in-State ownership. In States with high tax-induced ownership segmentation, they find a greater susceptibility of municipal bond yields to supply variation and heightened sensitivity of bond yields to local uncertainty.

There is no obvious tax advantage for investors from investing in municipal bonds or MBA bonds in the European markets, but the tax advantage of US municipal bonds plays an important role in their attractiveness to different types of investors. Chapter 2 describes eight different tax categories of municipal bonds: from Federal and State tax-free through to Federal bank qualified and Federal alternative minimum tax eligible. The different categories offer varying advantages, which influence borrowing costs, to different types of investor. In general, the bond's yield spread regresses most negatively on the most attractive tax categories.

Frictions in bank lending to SNGs

Chapter 1 compares bond issuance versus subnational government borrowing. USAID (2009) contrasts the two, highlighting differences in size of funding, maturity, interest costs, transaction costs, collateral requirements and methods of sale. Many subnational governments can meet their capital needs by assuming and repaying commercial debt, such as bank loans. By successfully repaying bank loans, they establish a positive credit history, which is an important first step towards the ability to make municipal bond issues. This experience informs interventions to support bond market development.

However, key supply-side frictions in the municipal lending market structure can restrict liquidity. These include tighter bank regulation since the GFC, bank/investor information asymmetry-related costs, and search costs. The GFC has restricted banks' margins and balance sheets and has been followed by the higher capital requirements of Basel III regulation (e.g. leverage ratio, capital ratio and a need to hold sufficient high-quality liquid assets to cover foreseen total net cash outflows over 30 days). Tighter regulation and low nominal interest rates make lending less attractive for banks, by lowering their margins and restricting the supply of credit and its subsequent investment. While a government-owned lending institution, such as the UK Public Works Loan Board (PWLB), does not suffer obvious credit frictions (its funding source is the UK Treasury), Chapter 1 highlights that greater regulation has reduced the competitiveness of specialist municipal lending banks globally, which means that SNGs may have to seek loans through a standard commercial bank, which might not be so well attuned to the detailed requirements of their related investment programmes. For example, Schnitzler (2017) highlights that Swedish commercial banks charge higher credit spreads to smaller, more indebted SNGs than larger ones.

Micro-level drivers are relevant to choice: Rauh and Sufi (2010) show that firms shift from bank loans to publicly traded bonds, as their credit quality increases, while Crouzet (2017) observes a trade-off between the flexibility of bank borrowing in the case of financial distress against the lower marginal costs of large bond issues and claims that public policy influences firms' financing mix.

Credit-pooling bond agencies: advantages versus new frictions

Versus individual bond issues: the SNG benefits from flexibility in the timing and size of borrowing from a counterparty or issuing their own bond individually, relative to participating in pooled issuance programmes. However, MBAs and MBBs claim to improve access to funding markets and bond liquidity (Katzman, 1980; Kidwell and Rogowski, 1983). Because of the heterogeneous nature of various SNGs in terms of size and credit rating, credit-pooling agencies offer different benefits to their participants and some SNGs benefit more than others from MBB participation. In the US, smaller communities with poorer credit ratings benefit the most when issuing debt through MBBs (Katzman, 1980; Cole and Millar, 1982; Kidwell and Rogowski, 1983). On the other hand, a large US municipality [5] may command an equal or higher credit rating than that of an MBA or MBB. It might believe that debt issued in its own name is sufficiently liquid and improves investor name recognition, as well as having a desire to develop its own credit history. Seeing limited benefit from joining a pooled bond issuance, it may choose to issue its own debt. While a large bond issuer can generate savings in the market from open tender, the credit-pooling agent has a niche role to fulfil for smaller and less experienced SNGs. For example, individual municipal bonds are issued through bond underwriters, who charge fees and generate gains (a cost to investors and issuers) from reselling these bonds to investors. Many individual US municipality bond issues are small, which leads to relatively high transaction costs (e.g. legal, distribution, printing, advertising and bond underwriting) as a percentage of total proceeds. On the other hand, the municipal bond bank offers economies of scale and bond issuing expertise. This is attractive to a municipality that may lack the financial knowledge, size or credit rating to issue bonds on an irregular basis.

A restriction for municipalities, joining the bond issuance programmes of an MBB is the relative lack of flexibility in timing. Most MBBs issue series of bonds two-to-four times per year and the issue process is time consuming, as the MBB invites participation and screens applications. By contrast, many individual SNGs issue at a time of their choosing in normal market conditions, notwithstanding costs and relative credit ratings.

Credit-pooling agency bonds typically trade in secondary markets at a yield premium to their respective sovereign bond yield curves, despite being rated in-line with the sovereign's debt. This is attractive to investors. Their bonds can only be issued if the

[5] I refer to municipality in the US literature throughout, because this is the target market of the MBBs, rather than higher-level counties and State bond issuers.

agency attains a minimum credit rating from an authorised credit rating agency. However, this gives rise to a unique set of frictions. The efficacy of rating agencies relies on their access to reliable and independent financial information. Inherent in public monitoring of a bond market is the ability of multiple participants to undertake independent and accurate credit analysis. Yet the credit rating agency is paid by the bond issuer, risking a business pressure on the rating agency to generate a threshold credit rating for the issuer.

Versus bank lending: an MBA acquires detailed knowledge of individual SNGs to rival that of a lending bank, as it builds membership. Municipal bond issues are often substantially larger than loans, with longer maturities, lower interest rates and requiring less collateral (USAID, 2009; Danilowska, 2009). If it operates within an efficient bond market, an MBA can lower costs for certain issuers by unbundling the services of a lending bank. In terms of monitoring, bond markets rely upon public disclosure and analysis of municipal financial information, which compares with the lending banks' in-house analysis. Public monitoring and disclosure are consistent with greater transparency for all public financial institutions.

MBAs' bonds: joint and several guarantee and government moral obligation

MBAs outside the US either enjoy an implicit government guarantee of their bond issues or they issue bonds with the joint and several guarantee of their members. This guarantee means that each of two or more parties are liable on an obligation to deliver on a promise stated in a contract. If a breach of contract takes place, liability arises to honour the contract for either a debt due, or damages, even if the creditor approaches just one provider of the guarantee (Revesz, 2002). Literature on joint-liability lending covers screening, monitoring and enforcement of repayment (Ghatek and Guinnane, 1999), adverse selection (Ghatek, 1999) and risk matching (Ahlin, 2009) in microfinance, but there is little written within the municipal bond literature. The joint and several guarantee creates a coinsurance design, through which SNGs with strong borrowing capacities subsidise weaker ones when jointly issuing a bond. A weakness of this concept is when SNGs are reluctant to provide such a guarantee for their liabilities (Schnitzler, 2017). UK and French examples underline the difficulties in building new pooled credit markets with participating SNGs' joint and several guarantee (see AFL and UKMBA websites).

With respect to government guarantees of pooled bond issuers, Hsueh and Kidwell (1988) study the effect of the moral obligation of the State on pooled credit markets relative to individual bonds, namely the Texas Permanent School Fund bond guarantee programme. This is a stronger condition than the moral obligation of the State to MBB bond programmes and allowed school districts to achieve interest cost savings of between 40-98 basis points for single A up to Baa-rated issuers respectively, while AA-rated issuers enjoyed no interest costs savings and AAA-rated issuers suffered a penalty yield of 18 basis points above that of other AAA-rated issuers.

Bond characteristics – foreign currency bonds

US and European SNGs rarely issue bonds in a foreign currency. On the other hand, for the European MBAs, foreign currency bonds represent the majority of their bond issuance. McBrady and Schill (2006) test the opportunistic motive for foreign currency borrowing by governments and agency issuers, who have cash flows exclusively in their respective local currencies (similar to MBAs and MBBs). They conclude that covered and uncovered interest yield differentials across currencies are important in choosing the currency of denomination for international debt. Chinn and Ito (2000) argue for larger-sized foreign currency issues if an issuer is based in a small currency market (e.g. the Nordic issuers) and smaller sized issues if the issuer is based in a large currency market (e.g. euro based issuers). Black and Munro (2010) argue that non–government agencies within smaller markets issue swap-covered foreign currency bonds to arbitrage deviations from covered interest rate parity, to access foreign investors, and to issue larger or longer-maturity bonds. The propensity to issue a bond offshore is related to bond characteristics, such as size and tenor, and bond market characteristics, such as liquidity. The economic background for foreign currency bond issuance is discussed in Chapter 3.

RESEARCH QUESTIONS

By the 1990s, over 60 developing countries had established financial intermediaries, such as municipal development funds, to provide credit to SNGs and fund infrastructure investment, according to the OECD. However, few of these organisations have evolved into market-oriented suppliers of credit, capable of mobilising private sector savings, or leading to private sector participation in the municipal credit market. By contrast, in developed markets there has been a slow move towards public institutions, such as SNGs, raising their own funds in capital markets. Decentralisation in many developed countries may shift the burden of funding investment programmes to SNGs. Thus, the local authority credit market is an important source of funding, matching long-term financing to infrastructure investment programmes.

This study examines the financial innovation of developed market SNGs to raise private funds. It addresses clear gaps in the existing literature — there is only one other paper on European municipal bond agencies (MBAs) relevant to Chapter 1; none on MBAs are relevant to Chapter 3; and the database for Chapter 2 is substantially more detailed than any in the current literature. In particular, the thesis compares three important alternative means for raising long-term debt:

i. Direct government-backed lending

ii. Individual bond issues

iii. Municipal credit-pooling agency backed bond issues

Given a UK focus, Chapter 1 addresses which of these alternatives - (i) or (iii) - is best suited for SNGs, by examining the relative trade-offs. What is the yield spread of pooled municipal debt over sovereign debt in the presence of either a joint and several guarantee of pool members or a sovereign guarantee of the issuer? What are its determinants? To address these questions the performance of European MBAs is reviewed. This chapter addresses frictions in municipal lending.

Chapter 2 examines which of the alternatives - (ii) or (iii) - is best suited for SNGs by examining the relative trade-offs in the primary market. Is there an interest cost advantage to a municipality by participating in a pooled agency bond issue relative to issuing their own bond? Are participants motivated by credit rating and issue size advantages? I look at the US market to assess this question, given that both MBBs and individual SNGs issue bonds here.

Chapter 3 investigates a potential advantage of MBAs by examining, within (iii), the role for issuing domestic as opposed to foreign denominated bonds. Municipal bond agencies are flexible in the currency of their bond issuance. Are they reducing issue costs or simply chasing customer appetite? Here the performance of their foreign currency bond issuance is considered, including discussion of covered interest parity (CIP) and the channels of its failure. CIP is a no-arbitrage condition that is supported by minimal transaction costs, low political risk, low credit and counterparty risk, low liquidity risk and low measurement error. Deviations from CIP contradict the operation of a frictionless foreign exchange market. The breakdown of CIP allows MBAs to generate risk-free interest cost savings, relative to domestic bonds, when issuing bonds in foreign currency.

Concluding remarks

The following chapters will demonstrate that applying the funding model of a European MBA to the newly-formed UKMBA should allow it to generate interest cost savings for its borrowers, relative to borrowing direct from central government agencies, but that these savings are not conclusive; that the size of borrowing requirement and the credit worthiness of the borrower determine whether a municipality should participate in MBB bond issuing activity; and that European MBAs often, but not always, generate interest cost savings by issuing bonds in foreign currencies, relative to their respective domestic currency.

Despite a long and successful history in parts of Europe and Japan, municipal credit-pooling agencies do not have deep roots on a global basis. There are relatively few developed countries where municipal bond agencies or municipal bond banks are active, which leads me to investigate the growth potential of this niche of public finance. The two newest entrants to the cohort of MBAs are Agence France Locale and the UK Municipal Bond Agency. Both have found early progress to be hard earned. The former has issued a total of €3.0 billion of bonds in the five years since its launch, while the latter has yet to issue a bond. Yet the credit-pooling agency concept has achieved good traction in the five European countries which are studied in Chapters 1 and 3.

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Municipal Debt Finance and Mutualisation

CHAPTER 1: DOMESTIC YIELD SPREADS OF MUNICIPAL BOND AGENCY BONDS

Abstract

A municipal bond agency (MBA) funds its lending activity by the issuance of bonds on a regular basis. If it issues successfully, then it can generate interest cost savings for its participants, relative to borrowing from other channels. What spread over its sovereign yield might a newly launched UKMBA expect to achieve with its bond issues over time? Based on a European peer group, I use a synthetic control methodology to estimate the spread of domestic currency denominated MBA bond yields compared to the respective government's sovereign yield curve in secondary markets and determine that the UKMBA might expect to be competitive relative to a government-backed loans provider. I identify the best linear estimation model of European MBA yield spreads. Liquidity impacts the yield spread negatively, while duration, credit rating and coupon are significant and positive determinants.

Keywords: Municipal bond agency; joint and several guarantee; bond yield curve; yield spread

JEL Classification Numbers: G12, G21, H74

INTRODUCTION

The UK Municipal Bond Agency (UKMBA) is planning to issue bonds as a credit-pooling agency, in order to fund loans to English and Welsh local authorities. To establish a foothold in long-term local authority funding, it must demonstrate meaningful interest cost savings to local authorities, relative to their existing methods of raising funds for long-term projects. For example, a 10 basis point saving on current interest costs could represent up to £100 million per annum for British local authorities over the long run. Can it compete with the Public Works Loan Board (PWLB), the lender which represents almost 80% of local authority long-term financing? Most local and unitary authorities in England, Wales and Scotland currently borrow direct from the PWLB to fund capital investment projects. This agency of the UK Treasury draws funds from the National Loans Fund and lends money upon demand to local authorities. For new loans, the PWLB forms a 'Certainty Rate', which applies equally to all local authorities for their long-term borrowing. PWLB loans to local authorities were set at an annual interest rate premium of 80 basis points over the UK par gilt curve until October 2019, when it was increased to 100 basis points. It had £78.3 billion of fixed- and variable-rate loans outstanding to the sector at March 2019 and generated £2.9 billion of interest income in the 2018/19 financial year. Other local authority funding sources include private sector banks, with £18 billion of combined lending, while a small number of UK local authorities undertake their own bond issues, raising £4.3 billion in the above financial year (source: UK Ministry of Housing, Communities and Local Government).

If a UK credit-pooling agency is to thrive, it must issue bonds at a competitive yield, which will fund long-term loans to local authorities more cheaply than if they were to borrow directly from government-backed agencies or banks. This study investigates the spread over the local sovereign yield curve at which a UK credit-pooling agency can expect to issue fixed coupon, fixed term bonds in the presence of a joint and several guarantee of its members, in order to fund its lending activities to local authorities. I look to the mature European MBAs for guidance and investigate domestic currency bonds, which represent an important part of their funding. Of the six mature European MBAs' outstanding bonds, 33% were denominated in their respective domestic currencies at December 2016.

I compare the yield spreads relative to respective sovereign curves of bonds issued by these MBAs over time from a representative sample. Adopting a synthetic control methodology, a subsample of European MBA bond issues is used to statistically replicate bond issues made by a counterfactual UK MBA of the same design and credit worthiness, in order to compare pricing of these issues. The synthetic control group is created by matching on country and macro characteristics, given the difficulties in matching the bond issuer characteristics of a synthetic MBA with no history of bond issues. This provides a cross-sectional comparison of average pricing across the issuance design, which estimates how a mature UK MBA would have fared in open secondary market conditions over the period. The synthetic UK MBA's bond yield spreads are then compared with those of a synthetic PWLB bond issuer (created to replicate its aggregate lending activity) to determine the competitiveness of a mature bond agency.

I also observe how key determinants influence the bond yield spread to their respective sovereign yield curve, having first identified the best regression model to explain the yield spreads. There is one just recent European paper (Schnitzler, 2017) of relevance to this work. The majority of the literature covers the US municipal bond market; yet European and US municipal bonds have different features. I address gaps in the existing literature, as I strive to offer policy guidance to the newly created UKMBA. The literature review on pages 43-47 identifies a number of drivers of the pricing of municipal bond securities:

1. The price that the respective sovereign borrower of an MBA pays to borrow money in the securities markets, i.e. the interest rate on government bonds.
2. Liquidity of the securities: the bonds of large borrowers with many investors can be more easily traded in a secondary market than smaller issues.
3. Duration: the greater the remaining life on a bond, the greater its yield divergence from the benchmark sovereign yield, in general.
4. Credit risk: the amount of compensation required for risk of default.
5. Coupon: I follow the tax clientele literature to identify whether the tax status of different investors affects the relationship between coupon and yield spread.

Different regression models are compared to identify the impact of key determinants. While an OLS or GLS model achieves the highest R-squared in general, I test whether this is the best linear predictor. The literature often employs the use of lagged dependent variables among regressors. These may be correlated with error terms. Thus, identification of coefficients might require the use of instrumental variation. While liquidity and duration can be assigned at random and their effects on yield spread identified, they may themselves result from endogenous decisions of the market. I consider estimator bias.

Economic setting – municipal bank lending versus bonds

This chapter compares direct government-backed lending to subnational governments (SNGs) and municipal credit-pooling agency-backed bond issues, by examining the relative trade-offs. Government-backed lending is an important source of SNG long-term credit financing globally. However, a trend of decentralisation is shifting the burden of funding investment programmes to SNGs, including the issue of bonds for long-term finance. Among bond issuers, the MBAs function as intermediaries between SNGs and capital markets in their respective countries. They are organised either as government agencies or co-operative entities and provide access to long-term finance to their participants. They issue bonds either with a government guarantee or the joint and several guarantee of their members. The six oldest European MBAs maintain strong balance sheets and have never defaulted on a bond issue. Thus, they all command credit ratings in-line with their respective sovereign issuers.

Why issue bonds rather than borrow from government or banks? Peterson (2003) highlights that municipal lending banks bundle their services to SNGs, which means that they do not price them to correspond with their incremental costs. Typically, such a bank lends to all SNGs at the same interest rate with no differentiation of credit quality from one SNG to another and a failure to price services that correspond with their incremental costs. The UK's PWLB is one example. A local authority, lacking experience in financial markets, may find the bundled services and pricing of a municipal lending bank more attractive than a large and better credit-rated local authority, which may have more sources of credit available. However, the nature of many of these loans is that they consist of small amounts, reflecting the size and requirements of their recipients, which can lead to relatively high transaction costs.

The relationship banking skills of a municipal lending bank are important. Providing loans to fund investment projects, its relationship banking service includes the structuring of SNG budgets, investment programmes and financial analysis for SNGs that lack credit market experience. As long as municipal lending banks enjoy preferential access to low-rate long-term savings, they can provide low-cost, long-term loans to SNGs to finance local infrastructure investment. In the case of Crédit Local de France, this was provided by La Poste's savings plans for small savers; in Italy, the public bank, Cassa Depositi e Prestiti, is 83% owned by the Ministry of Economy and Finance and raises much of its funding through postal savings; in the UK, the PWLB draws its funding from the National Loans Fund, part of HM Treasury. However, many municipal lending banks have lost their exclusive access to sources of low-cost, long-term savings, obliging them to compete for funds with the broad market. Post the Global Financial Crisis (GFC), the higher capital requirements of Basel III regulation have limted their ability to supply credit, relative to previous years. Banks' margins and balance sheets are more restricted by tighter capital requirements that enforce increases in bank liquidity and decreases in bank leverage. This impacts municipal and other lending for commercial banks, with a resultant impact on the price of credit.

At less than US$1,500 billion globally, SNG lending is a relatively small part of total bank lending activity (OECD/UCLG, 2016), so many banks subsume this into their broader commercial banking activity, possibly eroding the special relationships that support lending to this community. Without a well-established specialised municipal lending bank as a partner, an SNG must seek loans through the standard commercial banking network, which might not be so well attuned to the detailed requirements of its related investment programme. Schnitzler (2017) finds evidence in Sweden that commercial banks charge higher credit spreads to smaller, more indebted SNGs than larger SNGs.

Municipal bond agencies

An MBA indirectly leverages on its country's borrowing capacity and to be effective, national institutions must be supportive. This includes a highly credit-rated central government; a legal framework that allows interventions if an SNG falls into financial hardship; and prudent borrowing by subnational governments. An MBA builds a detailed knowledge of individual SNGs to rival that of a lending bank. If it operates within an efficient bond market, it can lower costs for certain issuers by unbundling the services of a lending bank. In terms of monitoring, bond markets rely upon public disclosure and analysis of municipal financial information, contrasting with the lending banks' in-house analysis. This is consistent with greater transparency for all public financial institutions.

In a world where high quality sovereign bonds command low real and nominal yields, the high credit ratings and relatively low risk of MBA bonds are attractive to investors, given that they typically trade in secondary markets at a yield premium to their respective sovereign bond yield curves. Attaining a threshold credit rating from an authorised credit rating agency gives rise to a unique set of frictions. The efficacy of rating agencies relies on their access to reliable and independent financial information. Inherent in public monitoring of a bond market is the ability of multiple participants to undertake independent and accurate credit analysis. Yet the credit rating agency is paid by the bond issuer, which might create a business pressure on the agency to generate a threshold credit rating for the issuer.

In the Introduction to the thesis, I define how each of the mature European municipal bond agencies enjoy either an implicit government guarantee of their bond issues or they issue bonds with the joint and several guarantee of their members. This enables an MBA's risk to be equated with that of its guarantor or liable institution by the credit rating agencies. KommuneKredit, Kommuninvest, MuniFin and AFL bonds are subject to the joint and several guarantee by their respective members, whereby each shareholder guarantees the entirety of the relevant agency's liabilities. A joint and several guarantee creates a coinsurance design through which SNGs with strong borrowing capacities subsidise weaker ones when jointly issuing a bond. The MBA business model is challenged, if SNGs are reluctant to provide a joint guarantee for their liabilities, unless an equivalent guarantee can be installed, such as the implicit support of the government or government ownership. In effect, BNG and KBN are controlled by their respective central governments, given their respective ownership. NWB, is partly owned by the Kingdom of the Netherlands and its status as a government-related entity allows an implicit government guarantee of liabilities. While no formal government guarantees exist for these three agencies, their respective roles in the Dutch and Norwegian public sectors imply a high probability of government support if needed. For example, in the case of NWB, Standard & Poor’s states in its annual assessment that ‘We base our ratings…solely on…an almost certain likelihood of timely and sufficient extraordinary government support in the event of financial distress.’

To give a background, the individual European MBAs are briefly described. The first subnational government bond funding agency was created in Denmark in 1898. A Norwegian agency followed in 1926 and agencies were founded in Sweden in 1986 and Finland in 1990. The Netherlands is home to the two largest agencies (BNG Bank – founded in 1914; and NWB Bank – founded in 1954), as measured by balance sheet. All these MBAs hold credit ratings in-line with their respective sovereign. Agence France Locale was created in December 2013 and is owned by French local authorities. Its long-term Moody’s credit rating of Aa3 compares with a French sovereign rating of Aa2. Details of the European MBAs are shown below:

Table 2: The Six Major European Municipal Bond Agencies

	Kommunekredit Denmark	NWB Netherlands	BNG Netherlands
Benchmark currency	EUR/USD	EUR/USD	EUR/USD
Ownership	100% SNGs	17% central government, 81% water boards, 2% provinces	50% central government, 50% SNGs
Loan guarantee	Joint & several guarantee by members	Implicit government guarantee	Government owned
Purpose	Danish public sector lending only	Dutch public sector and water board lending	Dutch public sector lending only
Profit motive	Non-profit	Profit maximising	Non-profit
	KBN Norway	**Kommuninvest Sweden**	**MuniFin Finland**
Benchmark currency	EUR/USD	SEK/USD	EUR/USD
Ownership	100% central government	100% SNGs	30.66% Keva, 16% central government, 53.34% SNGs
Loan guarantee	Government owned, Letter of Support	Joint & several guarantee by members	Jointly guaranteed by SNGs
Purpose	Norwegian public sector lending only	Swedish public sector lending only	Finnish public sector lending only
Profit motive	Profit maximising	Non-profit	Profit maximising

Source: MBA data

Each of the European MBAs act on behalf of SNGs at two levels in their respective countries (municipal/water authority and regional), as defined in the Introduction:

Table 3: The Tiers of Subnational Government in the Countries of Interest

	1st Level	2nd Level	Number of MBA members
Denmark	98 municipalities	5 regions	all munis and regions
Finland	311 municipalities	19 regions	all munis and regions
France	36,697 municipalities	101 departments	292 shareholders
Netherlands	383 municipalities	12 provinces	public sector: local and water authorities, housing and healthcare institutions
Norway	422 municipalities	18 regions	all munis and regions
Sweden	290 municipalities	21 counties	277 munis + 11 counties

Source: MBAs

Non-interest costs of the agencies

While I compare interest costs between MBAs' bonds and other forms of capital fund raising, MBAs do incur other costs, which may be attributable to participating SNGs. The annual non-interest administration costs of a European MBA are 7-10 basis points of assets under supervision (source: MBAs' annual accounts). These are financed by MBA revenues that include interest received from lending to local authorities by the agency. Thus, they are not a direct cost of a bond issue. On the other hand, the one-off transaction costs of primary bond issuance include syndication, placement, credit rating, legal, printing and other fees. These approximate to 5-10 basis points of the principal and are embedded in the issue price of the bond.

The paper is divided as follows: Section 2 summarises relevant literature. Section 3 compares the bond issues of a synthetic UK MBA and a synthetic PWLB. Section 4 discusses the yield spread data and important variables and defines the best linear regression model. Section 5 presents regression results on an unbalanced panel of yield spreads and checks the robustness of results. Section 6 contains concluding remarks.

LITERATURE REVIEW

Table 4: Literature Highlights Determinants of European MBA Yield Spreads

Paper	*Topic*	*Main Results*	*Comments*
LIQUIDITY		**A number of studies estimate liquidity by the bid-offer spread of US municipal bonds or Länder bonds**	**Data providers only publish mid prices for European muni bonds in OTC markets**
Schuknecht et al. (2009)	SNG yield spreads	Yield spreads over benchmark bonds depend significantly on liquidity and credit quality	Germany and Spain pay liquidity related rate premia
Amihud (2002)	Estimating liquidity	Uses a measure of price return relative to volume	Study restricted to equities
Wang, Wu & Zhang (2006)	Liquidity, credit risk and tax	Liquidity, default risk and taxes are all strongly significant factors on US muni yield spreads	Estimate liquidity by the Pastor & Stambaugh method
Harris & Piwowar (2006)	Liquidity	US municipal bond market liquidity increases with credit quality and falls with time-to-maturity	Municipal bond transaction costs are more than those of equity trades
Lin, Liu, Wang & Wu (2009)	Liquidity	Much of yield spread between muni and taxable bonds driven by liquidity premium	Liquidity premium is correlated to maturity, size, volume, coupon
Ang, Bhansali & Xing (2010)	Liquidity, credit risk and tax	Liquidity is a more important driver of yield spread than tax	Compared municipal bonds with Build America Bonds
CREDIT RISK		**Credit ratings recognised as a driver of yields in corporate and government bonds**	**Credit risk drives yield spreads of European municipal bonds**
Capeci (1991)	Credit risk	Effects of credit rating changes are large and significant	Credit ratings changes impact yield spreads directly and indirectly
Canuto & Liu (2013)	Financial crisis and credit risk	Subnational yield spreads rose by an average 46bps over two years through the credit crisis	SNG yield spreads depend on credit risk, liquidity, risk appetite
Cornaggia et al. (2015)	Credit risk	Upgrades in credit rating reduce credit spreads	Argues to include credit ratings in regressions
TAXATION AND COUPON		**Given tax exemption, much US literature identifies tax as a significant factor in yield spreads**	**There is no European municipal bonds investor tax advantage**
Schaefer (1982)	Tax clientele	High coupon bonds are primarily held by low tax payers and low coupon levels by high tax payers.	Tax clienteles: refer to percentage of total return from coupon income
Ang, Bhansali & Xing (2014)	Taxation	The tax exemption on US municipal bonds lowers yields. Credit risk and illiquidity raises yield spreads	The financial crisis reversed relationship of municipal bond and Treasury yields
LAGGED DEPENDENT VARIABLE		**Time persistence of bond yields: add lags of dependent variable**	**Debate as to the best models, given OLS bias**
Barrios et al. (2009)	Time persistent bond yields	They use a GMM method of Arellano & Bond (1991)	Optimal for a small number of time periods
Afonso et al. (2013)	Time persistent bond yields	They propose 2SLS with cross-sectional weights. FGLS similar results	Accounts for cross-sectional heteroscedasticity

The Nordic Model - Local Government, Global Competitiveness in Denmark, Finland and Sweden (jointly authored by Kommunekredit, MuniFin and Kommuninvest, 2012) states that subnational governments here have a broader portfolio of responsibilities than in most other countries and, thus, are responsible for a higher proportion of total taxation and government spending. The Nordic MBAs have never experienced a default. However, even after the creation of Kommuninvest, individual Swedish SNGs still experienced stress. Von Hagen et al. (2000) show that by 1998, 87 of them had applied at least once for central government grants during respective financial crises, thus avoiding bankruptcy.

There are no MBAs in Germany, Italy or Spain and the majority of European SNG literature covers regional bond issuers rather than those at the municipality level. For example, Schuknecht et al. (2009) claim that German and Spanish SNG bonds pay liquidity-related interest rate premia relative to their respective sovereign bonds. However, large inter-governmental transfers have suppressed these premia and delinked bond prices from underlying fiscal risks, such as debt levels. Furthermore, the public debt of German SNGs benefits from an implicit guarantee of the German States. In Italy, Pinna (2014) claims that the bond yields of the regions are affected by an issuer's specific economic factors. By contrast, Italian cities' and provinces' default risks are related to that of the sovereign, due to the reliance of local authorities' revenues on central government transfers. Canuto and Liu (2013) quantify the effect of sub-sovereign credit ratings, liquidity and investor risk appetite on yield spreads across European SNGs in 22 countries. Schnitzler (2017) finds evidence of risk-sharing within the Swedish municipal bond market and net gains of improved credit across all borrowers.

The majority of relevant literature covers the US municipal bond market, while this paper focuses on European municipal bond markets. European and US municipal bonds have some different features. For example, investing in many US municipal bonds is tax efficient for domestic retail investors, relative to other bond markets, but there is no explicit tax advantage to investors in investing in European municipal bonds. Nonetheless, key threads of the US literature are relevant and I draw upon this and other literature to apply the tools to this analysis.

Determinant 1: Liquidity, investor transparency and trading costs

Liquidity is widely recognised as an important driver of bond yield spreads. The US municipal bond market is notoriously illiquid. Harris and Piwowar (2006) find high dealer mark-ups and transaction costs and a lack of transparency. The average municipal bond traded just 15 times in total over its life. It is not until the 99.9th percentile of their sample that they find municipal bonds that trade up to six times per day. They show that liquidity increases with credit quality and decreases with investment complexity, time to maturity and time since issue. Wang et al. (2006) find that the effects of liquidity, default risk and personal taxes on the relative yields of municipal and treasury bonds are all strongly significant, when regressed on by US municipal bond yield spreads. The liquidity premium explains 7-13% of yield spreads for AAA bonds and 8-20% for BBB bonds. Lin et al. (2009) find that a substantial portion of the yield spread between the relative yields on municipal and taxable bonds is attributable to the liquidity premium, which is highly correlated to maturity, size, age, coupon and bond volume.

Ang et al. (2010) underline that liquidity is a more important component of the municipal yield spread than tax, by comparing with the Build America Bonds (BABs) programme of 2009-10. The latter bonds carried no tax exemptions. Ang and Green (2013) show that a typical US municipal bond trades just twice a year and the liquidity and information effect on transaction costs is equivalent to 103 basis points of turnover. Marlowe (2013) recognises the lack of liquidity in the US municipal bond market and claims that 10-20% of the municipal bond yield spread is attributable to liquidity risk. He constructs an 'implied bond liquidity' from the weighted average of observed liquidity in all portfolios that hold the bond, even if the bond does not actually trade. Intuitively, it would be expected that a bond held by an active investor has greater potential liquidity than a bond held by a passive investor.

So how should liquidity be measured? Some German Länder bonds are exchange traded, which allows Heppke-Falk and Wolff (2008) to develop proxies of liquidity from bond prices' bid-offer spreads. But most European municipal bonds are traded over-the-counter. So there are no published exchange data on volumes traded or price spreads over time in my sample. Data providers disclose period-end mid-price and yield-to-maturity for each bond, which allows calculation of the total value of bond issuance outstanding. This approach is supported by papers on US municipal bond banks (Kidwell and Rogowski, 1983; Reid, 1990) and municipal bonds (Namvar et al., 2015), which identify the value of bond outstanding as an instrument of liquidity. In corporate and government bond markets, Chakravarty (1999) regresses realised bid-offer spreads on liquidity and finds that the spread falls with rising trading volume and rises with time to maturity and after-tax yield. He inspects each bond with at least one buy and one sell transaction per day and defines the bid-offer spread as the difference in the average buying and selling prices. Focusing on stock price returns, Amihud and Mendelson (1986) also use the bid-offer spread as an instrument of liquidity. Amihud (2002) later developed average daily return relative to a stock's daily dollar volume as a measure. This is interpreted as the daily stock price reaction to a dollar of trading volume.

Determinant 2: Duration or time to maturity

Duration is a measure of a bond price's sensitivity to changes in interest rates and is an important indicator of interest rate risk. It is defined as the weighted average term-to-maturity of a bond's cash flows, where the weights are the present values of each cash flow as a percentage of the bond's price. Although most research includes duration as a regressor of yield spreads, Namvar et al. (2015) also find that US municipal bond yields are positively correlated to the time-to-maturity of the bond, in addition to the credit default swap premia of the issuer and are negatively correlated to a bond insurance dummy. I look at time-to-maturity as a regressor within the robustness checks.

Determinant 3: Credit risk

Liu and Thakor (1984) find that credit ratings have an independent effect on municipal bond yields, given the private information of the rating agencies. Capeci (1991, 1994) investigates how an SNG's credit rating affects its borrowing rate. He concludes that credit markets impose discipline on the SNG's fiscal behaviour and that the effects of changes in credit rating are statistically significant. An upgrade from Baa to Aaa (Moody's ratings) is associated with a reduction in the borrowing rate of approximately 1.5%. Debt levels impact bond yields directly. Ang et al. (2014) disaggregate the municipal bond yield spread into credit, liquidity and tax components. They show that the tax exemption on US municipal bonds lowers yields on average, although credit risk and illiquidity relate positively to yield spreads. After the 2008 financial crisis, a decomposed municipal yield spread over Treasuries comprised a tax component of -1.84%, a credit component of 0.57% and a liquidity component of 2.14%.

Determinant 4: Coupon and tax clientele

I identify a significant effect of bond coupon on municipal bond yield spreads. Schaefer (1982) demonstrates how bonds' tax clienteles relate to the fraction of its total return from coupon income relative to capital gain and claims that personal tax rates influence pricing and portfolio decisions in the gilt market - higher rate tax payers may desire lower coupon bonds than lower rate tax payers. Kim et al. (1993) show that the default risk in corporate bond coupons affects valuation and Elton et al. (2001) argue that the coupon is higher for lower-rated debt, so the tax burden is higher, which suggests a tax effect.

Methodology: introducing lags of the dependent variable into the model

Addressing the time persistence of yield spreads may require the inclusion of at least a one-period lagged dependent variable in regressions. Wang et al. (2006) and Zipfel and Zimmer (2013) identify high time persistence in yield spreads. A lagged dependent variable in the regressors implies that a classical OLS approach may not be the best method to solve the model, given estimation bias. They use instrumental variables.

Addressing the time persistence of yield spreads with respect to EMU sovereign bond yields, Afonso et al. (2015) include lagged dependent variables as regressors and propose a 2SLS solution with cross-sectional weights that accounts for cross-sectional heteroscedasticity. They also investigate Feasible Generalised Least Squares and achieve similar results to their 2SLS model, concluding that credit ratings and certain macro and fiscal fundamentals explain sovereign spreads.

Barrios et al. (2009) investigate the impact of different investor risk appetite regimes on the time persistence of yield spreads. They use a lagged dependent variable to correct for serial correlation. A GMM estimator is used to solve the dynamic panel data model, as described by Arellano and Bond (1991), but this has limitations for a long time series.

Nickell (1981) investigates the bias of the OLS estimator in dynamic panel models with fixed effects. He finds asymptotic biases in first order autoregressive models that use panel data, when estimated by OLS. The bias falls as a function of $1/T$. Judson and Owen (1989) compare different panel estimators for unbalanced samples of a range of macroeconomic datasets that include a lagged dependent variable among the regressors. They find that the OLS estimator with country dummies performs the best when the number of time periods, T, exceeds 30. For T less than or equal to 20, they argue in favour of a GMM approach. Beck and Katz (2004) argue that the Nickell bias is less than 2% when $T = 20$ and a lagged dependent variable is included among regressors.

COMPARING SYNTHETIC MBA AND SYNTHETIC PWLB BOND ISSUES

European MBA bonds are traded in secondary markets by a number of investment banks and dealers on an Over-the-Counter (OTC) basis, where transaction volume is not reported publicly. To access a representative sample of volumes traded requires data provision direct from the dealers that trade the bonds. Therefore, my focus on the access to credit is on price.

Deriving municipal bond spreads

My objective is to estimate the yield spread relative to a UK sovereign curve that a synthetic UK municipal bond agency, with a credit rating in-line with its sovereign, might expect its bonds to trade at over time. Firstly, I calculate the spreads of the yield-to-maturity of a representative sample of European MBA bond yields, duration-matched to their respective government zero-coupon yield curves, and then I use a synthetic control methodology to match European results to the UK and estimate a UK yield spread.

The yield-to-maturity over time of the sample of municipal bonds is observable. Estimating government bond yield curves requires more work: it is possible to identify the benchmark constituents of government yield curves over time, which provides the building blocks of a sovereign yield curve. A zero-coupon yield curve provides a reference point to estimate the present value of money across different countries. Using monthly benchmark data, I calculate zero-coupon government yield curves for Denmark, Finland, the Netherlands, Norway and Sweden. Different central banks adopt different methodologies across Europe. To follow a common process for all jurisdictions, the Nelson-Siegel-Svensson method is adopted across all five markets. This process is defined within the Appendix. It can offer an improved fit to the data and a smoother shape relative to the Nelson–Siegel curve, which has fewer parameters. On the other hand, the model can struggle with irregular yield curves.

Selecting representative bonds

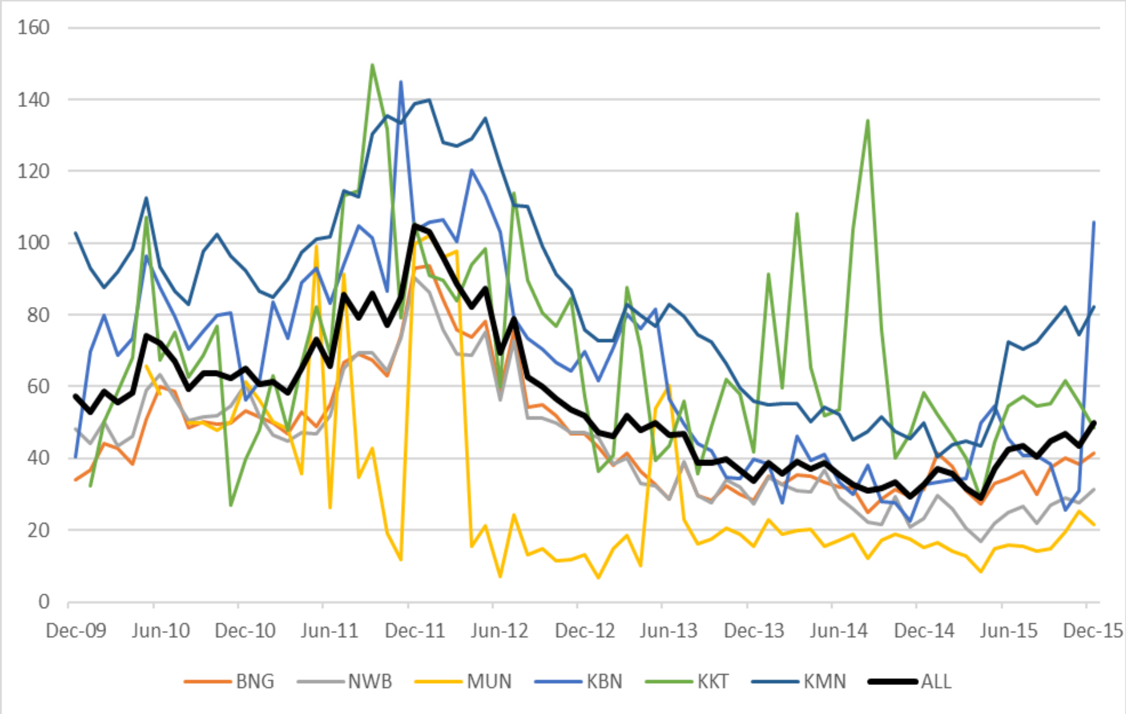
The six European MBAs issued 859 fixed coupon, fixed maturity-date bonds between 2010-15, which represents approximately 85% of all their issued bonds. Of these, 116 were domestic currency bonds. The sample also includes bonds that may have been issued before 2010 and were outstanding during the period of review. The sample includes an unbalanced panel of 70 bonds, issued by the MBAs, in secondary markets at monthly intervals within the period December 2009 to December 2015. One criterion for inclusion in the sample is that bonds are actively traded and therefore have price variation over time. The MBAs have issued several bonds as private placements, which subsequently scarcely trade in secondary markets. These are excluded from consideration, so that the adopted sample represents over 52% of bonds with suitable liquidity. The selected bonds exhibit monthly price movements almost all of the time and are subject to their respective issuing agency's credit rating.

Bond selection is representative of all the MBAs' respective issuance programmes. The majority of the PWLB's loans in the UK are for terms of more than 10 years. However, there are relatively few European MBA bonds in issue of that term or longer, which impacts inference for longer-dated synthetic UK MBA [6] bonds. I select bonds with a broad cross-section of coupons and time-to-maturity, whose prices are directly observable over time. Each of the six agencies has active bond issuance programmes. BNG, NWB and MuniFin issue domestic currency denominated bonds in euros and the other MBAs issue domestic currency bonds, denominated in Swedish, Norwegian and Danish krone respectively. I draw 16 bonds from BNG and NWB, 14 from Kommuninvest, 9 from Kommunekredit, 8 from KBN and 7 from MuniFin, which reflects the number of domestic currency bonds, issued by each agency over the period. The 70 bonds generate 2,856 observations over the period December 2009 – December 2015. The mean size of bond issuance outstanding is €683m, the median is €350 m; the range is from less than €10 m up to €3,377m.

Four bonds generate monthly data throughout the period. The other bonds either mature before the end or are issued after the start of the period under review. This defines an unbalanced data panel of each municipal bond yield to its respective zero-coupon government yield curve, matched by duration. The distribution of yield spreads over the whole sample is not normal. The mean yield spread over the respective sovereign yield curve over the full time period is 51 basis points, the median yield spread is 45 basis points and the standard deviation is 33 basis points. The range is from -1 basis point to 207 basis points and 8.7% of all observations are in excess of 100 basis points. The mean yield spread of all bonds outstanding peaked at 104 basis points in December 2011 and declined thereafter.

[6] Note the difference in syntax that I use throughout of UK MBA for a synthetic UK municipal bond agency and UKMBA for the actual UK Municipal Bond Agency

Figure 4: Average Bond Yield Spread by Issuer and Month (basis points)



Source: Calculated as the average of yield spreads observed each month; MUN is MuniFin, KKT is Kommunekredit, KMN is Kommuninvest; ALL is a simple average of all bonds outstanding each month

Table 5 shows the average yield spreads and bond duration over 2010-15 by individual issuer. On average, the Dutch and Danish issues are of longer duration than those of KBN, Kommuninvest and MuniFin:

Table 5: Average Bond Duration and Yield Spread for Each Issuer

Issuer	Mean Yield Spread	Standard Deviation	Mean Duration
BNG	42.4	24.8	7.27 years
Kommunekredit	62.2	32.1	6.65 years
NWB	39.9	23.9	6.50 years
Kommuninvest	78.5	36.9	5.04 years
MuniFin	31.4	31.5	4.15 years
KBN	60.1	29.4	3.03 years

Source: Calculated

Using synthetic control to create a UK MBA yield spread

I want to derive a synthetic UK MBA bond yield spread over time from the other European MBA spreads. The UK Municipal Bond Agency is a less mature organisation than the six large European MBAs. Before October 2019, the proposed operating model of the UKMBA followed the joint and several guarantee of bond issuance design. Moody's confirmed the credit rating of the UKMBA at Aa3 in its periodic review of April 2019. This represents a one notch discount to the credit rating of the UK government. To quote Moody's rationale: 'The credit profile of the UK Municipal Bond Agency reflects the strong credit quality of the local authority sector and the presence of structural enhancements to the pool. The credit challenges are the start-up nature of the agency and the strong incumbent of the Public Works Loan Board, which provides competitive finance to the sector with easy access.' The six mature European MBAs are all rated in-line with their respective sovereigns' credit ratings.

To compare yield spreads from existing European data, I consider a counterfactual that is based on a synthetic mature UK MBA being the established dominant provider of credit to UK local authorities, as is the case in the Netherlands and the Nordic countries. I assume that it would issue bonds on the joint and several guarantee of its member SNGs. In this case the synthetic UK MBA might command a credit rating in-line with its sovereign.

Creating controls to approximate the UK municipal bond issuer

Synthetic control methodology is often used to estimate treatment effects on an existing bond issuer. Controls can be generated at country, macro-economic or issuer levels. In this case, the UKMBA has not yet issued a bond, so there are no municipal bonds or issuer characteristics over time to match on, in order to estimate a yield spread. This necessitates using country and economic variables in order to create the optimal weightings of the existing MBAs to estimate the yield spreads of a synthetic UK MBA over 2010-15.

I minimise the mean square prediction error of a set of predictors from the five relevant European countries to variables such as generic government bond yields and macroeconomic variables over the period 2000-15. These include investment grade bond yields; change in real GDP; GDP per capita; unemployment; public debt as a percentage of GDP; financial debt as a percentage of GDP; government gross debt; government net lending; and inflation. I match on government bond yields rather than investment grade spreads for two reasons:

1. A full time series is available on 10-year government bond yields for all countries from December 2000, (compared with December 2003 for investment grade yield spreads for all countries);
2. Investment grade bond indices may not have the same attributes (e.g. credit ratings and duration) from one country to another, so matching may not be like-for-like.

The variables that provide the optimum predictor balance for government bond yield over the observation period include bond yield; change in real GDP; inflation; unemployment; private debt as a percentage of GDP; and non-financial debt as a percentage of GDP. Table 6 highlights the balance of the predictors of the UK variables:

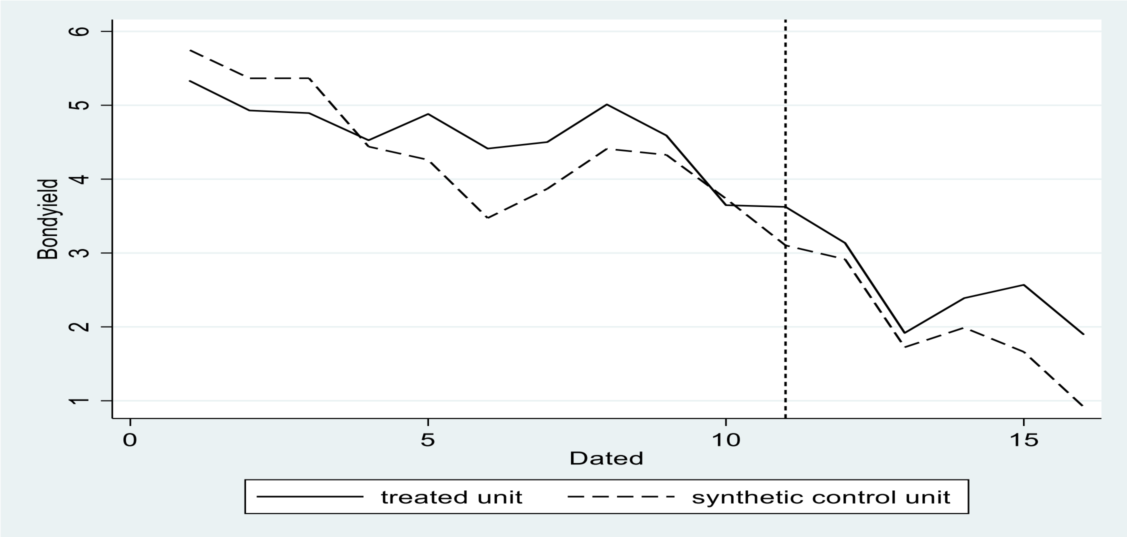
Table 6: Treated versus Synthetic Estimates of Control Variables

Date	Treated	Synthetic
Bond yield	4.67%	4.50%
GDP annual change	1.81%	1.52%
Inflation	1.92%	1.91%
Unemployment	5.45%	5.53%
Private debt as a percent of GDP	224%	215%
Non-financial debt as a percent of GDP	89%	97%

Source: National accounts, Stata Synth; the columns compare actual variables of the UK from 2010 with those that the synthetic control method estimates

Figure 5 shows that this is not a perfect approach – the difference between the synthetic and actual UK 10-year government bond yield ranges up to 90 basis points over time, which weakens the case for inference. However, comparison over time of the UK 10-year government bond yield with a simple average of five European countries' bond yields offers no greater insight – the range of difference here is up to 96 basis points. I have found no other relevant bond-related time series than that highlighted above, which provides improved matching for inference on the yield spread of a synthetic UK MBA.

Figure 5: Difference Between the Synthetic and Actual UK 10-year Bond Yields



Source: Bloomberg and IMF; the treated unit is the UK 10-year government bond yield, the synthetic control unit is an optimal blend of Denmark, Finland, the Netherlands, Norway and Sweden 10-year bond yields

The synthetic control methodology suggests weightings for the estimated UK government bond yield of 44.5% Denmark, 30.4% Finland and 25.1% Norway and minimises the contribution of data from the Netherlands and Sweden to zero respectively. Applying these weightings to a synthetic UK MBA of structural similarity to the European peer group implies an expected mean yield spread to the UK zero-coupon sovereign yield of its bonds of 52.3 basis points in secondary markets over all of 2010-15. This is somewhat problematic for inference of longer-term synthetic UK MBA bonds, because Finland and Norway are home to the MBAs with the shortest duration bonds in the sample, on average. Table 7 shows the variation over time of the estimated spread.

Table 7: Implied Synthetic UK MBA Yield Premium over a Sovereign Yield Curve

Date	Danish MBA yield spread (bps)	Finnish MBA yield spread (bps)	Norwegian MBA yield spread (bps)	Estimated UK MBA yield spread (bps)
30/09/2010	68.7	49.9	75.6	64.7
30/09/2011	149.7	42.9	101.3	105.1
30/09/2012	80.6	14.8	70.4	58.0
30/09/2013	49.0	17.7	42.2	37.8
30/09/2014	76.0	17.1	27.8	46.0
30/09/2015	55.2	38.5	38.5	45.9

Source: Calculated relative to a respective government zero-coupon yield curve; the UK yield spread is estimated as 44.5% of the Danish spread + 30.4% of the Finnish spread + 25.1% of the Norwegian spread

Comparing synthetic bond issuance to PWLB lending

Having estimated a spread over the UK government zero-coupon yield curve of the synthetic UK municipal bond agency bond issuer over time, I compare this to the activity of the PWLB, which is a government-owned agency. According to its annual report, 'The PWLB has no resources of its own, rather it borrows from the National Loans Fund as and when it requires to fund its loans…. all loan repayments are paid over to the National Loans Fund.' The National Loans Fund is administered by HM Treasury. Most of its borrowing needs are met indirectly, through borrowing on its behalf by the Debt Management Office and National Savings and Investments. In its annual accounts, the PWLB discloses the term and amount of its loans to local authorities at the aggregate level. However, it does not provide details of its funding.

To compare with the bond issuance of a synthetic UK MBA, a synthetic PWLB bond issuer is created and its required bond issuance simulated to duration-match the funding for PWLB lending. The lending activity of the actual PWLB is typically longer in term than that of the other European MBAs. It grants loans to UK local authorities with terms of up to 50 years and only 27.5% of its outstanding loan book had a term-to-maturity of less than 10 years at its March 2019 year-end. By contrast, 84.4% of my sample of European MBA bond yield observations has a duration of less than 10 years and the longest observation is 20 years. For the purposes of this exercise, I am approximating the bond issuance required to fund the annual incremental funding needs of the PWLB for loans of less than 20 years. In practice, the new UKMBA will have to compete with the PWLB across a fuller range of lending terms.

Table 8 summarises the actual PWLB's aggregate loans outstanding to English and Welsh local authorities at various year-ends between March 2010 and 2016. The reason that the published average interest rates are different from the rates at which it issues loans to local authorities at any time is that the majority of loans in each period are existing loans whose term-to-maturity is rolling down over time. It is assumed that all existing loans are covered by synthetic bonds, which also roll down through time, in-line with the loans. In order to estimate bonds to be issued and redeemed for each maturity range in each period, I calculate the change in the synthetic PWLB bond issuer's net funding requirement from one year to the next (the period-end loans minus the period-start loans). To allow for covered loans that roll into a given period from a longer term-to-maturity period, I adjust by subtracting the assumed bonds that roll in with them. Conversely, to adjust for the bonds that roll out of a given period with loans to a shorter term-to-maturity period, I add back the assumed bonds that have rolled out. For the maturity '1-2 years' category, I assume that all loans at period-end will roll down into the maturity 'up to 1 year' category over the next 12 months; for the maturity '2-5 years' category, I assume that one third of loans at period-end will roll down into the maturity '1-2 years' category over the next 12 months; for the maturity '5-10 years', maturity

'10-15 years' and maturity '15-20 years' categories, I assume that one fifth of loans at period-end will roll down over the next 12 months.

Table 8: Approximate Profile of PWLB Loans Outstanding of Less Than 20 Years

Date	Principal Maturing up to 1 year (£ million)	Mid-Point Maturity 0.5 years	Average Rate	Average Duration
31/03/2010	1,391	30/09/2010	5.78	0.50
31/03/2011	1,414	30/09/2011	5.03	0.50
31/03/2012	1,159	30/09/2012	3.95	0.50
31/03/2013	1,283	30/09/2013	4.60	0.50
31/03/2014	1,401	30/09/2014	5.31	0.50
31/03/2015	1,372	30/09/2015	5.83	0.50
31/03/2016	1,361	30/09/2016	4.73	0.50
	Principal Maturing up to between 1 and 2 years	**Mid-Point Maturity 1.5 years**	**Average Rate**	**Average Duration**
31/03/2010	1,294	30/09/2011	5.36	1.46
31/03/2011	1,177	30/09/2012	4.65	1.47
31/03/2012	1,269	30/09/2013	4.62	1.47
31/03/2013	1,418	30/09/2014	5.38	1.46
31/03/2014	1,349	30/09/2015	5.88	1.46
31/03/2015	1,330	30/09/2016	4.80	1.47
31/03/2016	1,309	30/09/2017	5.31	1.46
	Principal Maturing up to between 2 and 5 years	**Mid-Point Maturity 3.5 years**	**Average Rate**	**Average Duration**
31/03/2010	3,845	30/09/2013	5.94	3.21
31/03/2011	4,476	30/09/2014	6.13	3.20
31/03/2012	4,034	30/09/2015	5.47	3.23
31/03/2013	3,939	30/09/2016	5.44	3.23
31/03/2014	3,732	30/09/2017	5.07	3.25
31/03/2015	3,903	30/09/2018	4.77	3.26
31/03/2016	4,264	30/09/2019	4.30	3.29
	Principal Maturing up to between 5 and 10 years	**Mid-Point Maturity 7.5 years**	**Average Rate**	**Average Duration**
31/03/2010	4,869	30/09/2017	6.75	6.01
31/03/2011	5,575	30/09/2018	5.64	6.22
31/03/2012	6,304	30/09/2019	4.70	6.41
31/03/2013	6,813	30/09/2020	4.45	6.46
31/03/2014	7,611	30/09/2021	4.34	6.48
31/03/2015	7,813	30/09/2022	4.40	6.47
31/03/2016	7,917	30/09/2023	4.37	6.48
	Principal Maturing up to between 10 and 15 years	**Mid-Point Maturity 12.5 years**	**Average Rate**	**Average Duration**
31/03/2010	4,439	30/09/2022	6.75	8.64
31/03/2011	4,447	30/09/2023	5.64	9.13
31/03/2012	5,985	30/09/2024	4.70	9.59
31/03/2013	7,037	30/09/2025	4.45	9.72
31/03/2014	6,961	30/09/2026	4.34	9.78
31/03/2015	6,817	30/09/2027	4.40	9.74
31/03/2016	6,744	30/09/2028	4.37	9.76
	Principal Maturing up to between 15 and 20 years	**Mid-Point Maturity 17.5 years**	**Average Rate**	**Average Duration**
31/03/2010	3,515	30/09/2027	5.65	11.34
31/03/2011	3,545	30/09/2028	5.41	11.53
31/03/2012	5,395	30/09/2029	4.37	12.41
31/03/2013	5,838	30/09/2030	4.24	12.53
31/03/2014	6,222	30/09/2031	4.26	12.51
31/03/2015	6,472	30/09/2032	4.26	12.51
31/03/2016	6,839	30/09/2033	4.21	12.55

Source: PWLB annual accounts

The above assumptions allow me to deduce changes in net funding from one year to the next within categories '1 to 2 years to maturity' and longer. Where the required funding is higher than at the previous year-end, I assume that the agency issues a bond half-way through the year to duration-match the change. I assume that the synthetic PWLB functions at zero cost and therefore the synthetic PWLB bond issuer issues bonds on the same terms that the actual PWLB makes new loans (i.e. 100 bps over the UK sovereign par yield curve pre-November 2012; 80 bps over the UK par yield curve post-November 2012). The PWLB publishes historical loan rates and gilt yields on its website, which allows me to calculate the yield-to-maturity and duration of the required bond issues. This implies a bond issuance profile, as outlined below:

Table 9: Profile of Bond Issuance Requirement to Fund Net Changes in PWLB Loans

Issue	Required Issue Size (£m)	Term to Match	Duration to Match	Yield of PWLB Bond to Issue	Implied Duration of PWLB Bond to Issue	Difference in Duration
30/09/2010	900	3.5	3.20	2.12	3.39	0.19
30/09/2010	800	7.5	6.22	3.52	6.66	0.44
30/09/2010	200	12.5	9.13	4.37	9.76	0.63
30/09/2011	1,000	7.5	6.41	2.88	6.80	0.39
30/09/2011	1,700	12.5	9.59	3.75	10.09	0.50
30/09/2011	1,700	17.5	12.41	4.22	12.55	0.14
30/09/2012	100	1.5	1.46	0.97	1.49	0.03
30/09/2012	600	7.5	6.46	2.03	6.99	0.54
30/09/2012	1,200	12.5	9.72	2.93	10.56	0.84
30/09/2012	400	17.5	12.53	3.55	13.18	0.65
30/09/2013	50	1.5	1.46	1.03	1.49	0.03
30/09/2013	750	7.5	6.48	2.88	6.80	0.32
30/09/2013	200	12.5	9.78	3.76	10.09	0.31
30/09/2013	400	17.5	12.51	4.10	12.66	0.15
30/09/2014	100	1.5	1.47	1.35	1.49	0.02
30/09/2014	300	7.5	6.47	2.82	6.81	0.34
30/09/2014	500	17.5	12.51	3.60	13.13	0.62
30/09/2015	100	3.5	3.29	1.52	3.42	0.13
30/09/2015	300	7.5	6.48	2.15	6.97	0.49
30/09/2015	800	17.5	12.55	3.02	13.72	1.17

Source: PWLB, calculated; "duration to match" is the duration of the principal outstanding in a particular term range; "difference in duration" measures the difference between the duration of principal outstanding and the implied duration of a bond to be issued to match the principal outstanding, i.e. it is column 6 minus column 4

To compare column 5 in Table 9 with the bond issuance of a synthetic UK municipal bond agency, I estimate the yield spread to a UK sovereign zero-coupon yield curve at which a synthetic UK MBA would issue bonds. The yield spread over time of the synthetic UK MBA is calculated by the synthetic control method, defined above. In Table 10, I compare the yield-to-maturity of bonds that duration-match the bond issuance of the synthetic PWLB with that of the estimated bond issuance of the synthetic UK MBA. The final column represents the difference between the two.

Table 10: Comparing a Synthetic PWLB Bond Yield to a Synthetic UK MBA Bond Yield

Issue	Required Issue Size (£m)	Term to Match	Yield of PWLB Bond to Be Issued	Synthetic UK MBA Bond Yield	Difference (bps)
30/09/2010	900	3.5	2.12	1.90	**0.22**
30/09/2010	800	7.5	3.52	3.01	**0.51**
30/09/2010	200	12.5	4.37	3.69	**0.68**
30/09/2011	1,000	7.5	2.88	2.89	**0.01**
30/09/2011	1,700	12.5	3.75	3.55	**0.20**
30/09/2011	1,700	17.5	4.22	3.92	**0.30**
30/09/2012	100	1.5	0.97	0.76	**0.21**
30/09/2012	600	7.5	2.03	1.69	**0.34**
30/09/2012	1,200	12.5	2.93	2.36	**0.57**
30/09/2012	400	17.5	3.55	2.75	**0.80**
30/09/2013	50	1.5	1.03	0.96	**0.07**
30/09/2013	750	7.5	2.88	2.39	**0.49**
30/09/2013	200	12.5	3.76	3.03	**0.73**
30/09/2013	400	17.5	4.10	3.42	**0.68**
30/09/2014	100	1.5	1.35	1.29	**0.06**
30/09/2014	300	7.5	2.82	2.52	**0.30**
30/09/2014	500	17.5	3.60	3.18	**0.42**
30/09/2015	100	3.5	1.52	1.34	**0.18**
30/09/2015	300	7.5	2.15	1.92	**0.23**
30/09/2015	800	17.5	3.02	2.53	**0.49**

Source: Calculated; column 6 is column 4 minus column 5; a positive value in the last column suggests that the synthetic UK MBA can issue bonds at a lower yield than a synthetic PWLB issuer

Table 10 suggests that bond issues of the synthetic UK MBA generate interest cost savings relative to bond issues of a synthetic PWLB over time, even after the Certainty Rate was cut in November 2012. There is no time when the difference in bond yields is greatest.

A number of factors undermine inference for UK MBA yield spreads. Firstly, when estimating the yield spread of a synthetic UK MBA over time by a synthetic control methodology, the error between the weighted bond yields of the existing MBAs' sovereign issuers and the actual UK government bond yield over time is large relative to the findings of Table 10 (see Figure 5).

Secondly, the derived UK synthetic control weightings include Finland and Norway, which are home to the shortest duration bonds, on average. A challenge for the UKMBA is that over £40 billion of the £55.9 billion of PWLB loans outstanding to English and Welsh local authorities are of more than 10 years' term at March 2019. By contrast, the existing European MBAs have issued a limited number of bonds of long duration.

Thirdly, Moody's has given the real UKMBA a lower credit rating than those of the mature European MBAs. If the UKMBA were to consistently trade in the medium-term at a one notch discount to the UK sovereign rating, then some of the yield advantage of this bond issuer might not be at the levels implied from the analysis.

THE REGRESSION MODEL

I now quantify the effect of key regressors on European MBA yield spreads. By comparing the observed yield of a municipal bond to its respective estimated sovereign zero-coupon yield of the same duration, I generate a 'municipal bond yield spread' to form the dependent variable. Monthly time series for a sample of representative municipal bonds provide sufficient trading activity and hence price and yield-to-maturity variation. The literature identifies liquidity, time to maturity/duration and credit risk as drivers of US municipal bond pricing. Following the European literature, I add coupon to the set of regressors. Certain clienteles of bond investors may be more sensitive to income than capital gains requirements, so I look at income and capital gains tax regimes across the relevant European countries on pages 69-70. In creating an instrument for liquidity, I am mindful of the limitations of reporting the secondary market activity of European municipal bonds. There is no exchange-published trading volume data available for European municipal bond trades. Publicly available market information is limited to price, issue outstanding and yield-to-maturity in this OTC market. Following Kidwell and Rogowski (1983) and Reid (1990), my instrument for liquidity is the value of municipal bond outstanding in a common currency. Monthly prices in euros are used.

The issued units of the six issuers' bonds are almost constant over time-until-maturity, subject to minor redemptions and tap issues. The exception is Kommuninvest's domestic benchmark bonds, which must have a minimum SEK 3 billion of outstanding issuance with a maximum bond size of SEK 25 billion. Following a primary issue of a benchmark bond, Kommuninvest issues taps in smaller volumes on an ongoing basis, until a bond has one year remaining to maturity. Within the robustness checks, I also look at monthly changes in value outstanding, price returns and variance of price returns over time as instruments, which follows the US literature.

Standard & Poor's grants all European municipal bonds in my study either AAA or AA+ credit ratings. These vary within issuer over time. I represent credit ratings by dummy variables: AA+ is the omitted regressor. The credit ratings of each of the MBAs have remained in-line with their respective sovereign throughout the period of the sample and changes always coincide with those of the MBA's respective sovereign agency. Hence their variation over time arises directly from Standard & Poor's revisions of sovereign credit ratings.

The linear regression model

I define Y_{ijt}, the dependent variable, as the municipal bond yield spread over its respective duration-matched sovereign bond yield in secondary markets.

It varies from issuer to issuer (i), bond to bond (j) and over time (t).

I estimate Y_{ijt} by way of linear regression in a model:

$$Y_{ijt} = \alpha + X_{ijt}\,\beta + Z_{ijt}\,\gamma + \epsilon_{ijt} \;;\; \epsilon_{ijt} \sim IID\,(0, \sigma_{\epsilon}^{2})$$

X_{ijt} is a vector of regressors, including liquidity, duration, coupon and credit rating;
Z_{ijt} is a vector of control variables.

Given the time persistence of bond yields and spreads, I also investigate linear regression models that include one or more lags of the dependent variable among the regressors. For example, I show a model with one lag of the dependent variable as a regressor:

$$Y_{ijt} = \alpha + Y_{ijt\text{-}1}\,\rho + X_{ijt}\,\beta + Z_{ijt}\,\gamma + \epsilon_{ijt} \;;\; \epsilon_{itj} \sim IID\,(0, \sigma_{\epsilon}^{2})$$

The lagged control regressors are very significant in all the relevant models.

REGRESSION RESULTS

If OLS regression achieves the highest R-squared and minimises prediction errors, then Gauss-Markov assumptions imply that it is the best linear predictor model. However, introducing lags of the dependent variable into the regression model can induce endogeneity. Thus, an instrumental variables approach might prove superior, instrumenting the explanatory variables by lagged values, or one can use GLS as an alternative method to address the possible bias of an OLS regression.

In Table 11, I estimate the model, defined on page 59, by OLS regression. Following the literature, municipal bond yield spreads are described as a function of liquidity, duration, coupon and the credit rating of the issuer, which vary across bond issuers and issues and over time. I am also interested in cross-section and time fixed effects.

Table 11: OLS Regressions of Municipal Bond Yield Spread as the Dependent Variable

Estimator	(1)	(1)	(1)	(1)	(2)	(2)	(2)	(2)
Constant	0.0455	0.0926	0.2000 *	0.3609 ***	0.0035	0.0248	0.0400	0.1417 *
	(0.1162)	(0.1298)	(0.0813)	(0.0883)	(0.0177)	(0.0413)	(0.0215)	(0.0529)
Liquidity (per €bn)	-0.0854 **	-0.0891 *	-0.0896 ***	-0.0855 ***	-0.0155 **	-0.0161 *	-0.0192 **	-0.0244 **
	(0.0332)	(0.0399)	(0.0160)	(0.0153)	(0.0060)	(0.0069)	(0.0067)	(0.0082)
Duration	0.0196 *	0.0173 *	0.0246 *	0.0221 **	0.0034 *	0.0035 *	0.0050 **	0.0064 **
	(0.0085)	(0.0075)	(0.0096)	(0.0085)	(0.0015)	(0.0014)	(0.0018)	(0.0025)
Coupon	0.0692 ***	0.0619 **	0.0432 **	0.0240 *	0.0102 **	0.0102 *	0.0083 **	0.0068 *
	(0.0131)	(0.0179)	(0.0122)	(0.0107)	(0.0040)	(0.0042)	(0.0031)	(0.0028)
Credit rating	0.2604 **	0.1833 *	0.1731 ***	-0.0912 *	0.0284 *	0.0304 **	0.0223	-0.0188
	(0.0769)	(0.0857)	(0.0253)	(0.0537)	(0.0133)	(0.0126)	(0.0148)	(0.0128)
Yield spread with one lag					0.8638 ***	0.8475 ***	0.8258 ***	0.7452 ***
					(0.0493)	(0.0536)	(0.0564)	(0.0681)
Time fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Issuer fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Number of observations	2856	2856	2856	2856	2786	2786	2786	2786
Number of bonds	70	70	70	70	70	70	70	70
Number of time periods	73	73	73	73	72	72	72	72
R-squared	0.320	0.496	0.462	0.702	0.833	0.862	0.837	0.869

Source: Calculated; cluster robust standard errors; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

All four contemporaneous parameters of Model 1 are significant. The bond yield spread depends negatively upon liquidity – the more liquid the bond, the tighter the yield spread. The bond yield spread depends positively upon duration, coupon and a bond credit rating — higher rated bonds imply higher yield spreads, except in the model with time and issuer fixed effects.

Introducing fixed effects to Model 1 improves the R-squared of regressions. The Wald test rejects the null hypothesis that the period coefficients are jointly equal to zero, implying that the time fixed effects model is appropriate. All regressors remain significant at least at the 10% level in the time fixed effects and issuer fixed effects models.

The best R-squared of 0.702 is achieved by the model that includes both issuer and time fixed effects. Although there is some loss of significance of both coupon and credit rating, the significance of liquidity and duration improves relative to the base model. The sign of the credit rating regressor turns negative. The time fixed effects model concludes that the effect of liquidity on the yield spread is similar to the base model in size and sign, but the respective impacts of the other regressors are lower. Within the issuer fixed effects model, the effect of duration is somewhat greater than in other models. The effects of coupon and credit rating fall.

All models without lag regressors suggest that yield spreads fall by just under 9 basis points per €1 billion increase in outstanding issuance. While these numbers are statistically significant, from an economic point of view, this is not a large movement. Recall that the median bond size of the sample is €350 million, so a €100 million shift either side of this makes less than one basis point of difference to the bond's yield spread.

A one-year increase in duration adds between 1.7 and 2.5 basis points to the yield spread, depending upon which model is used without lag regressors. With 72.5% of the UK competitor PWLB's loan book being more than 10 years in term, this should be an important planning consideration for a UK MBA. However, only 15.6% of the bonds in the sample are of a duration longer than 10 years, thus affecting inference.

Contemporaneous regressors do not correlate with the error terms within Model 1: the correlation coefficients between liquidity and the error terms, duration and the error terms, credit rating dummy and the error terms, and coupon and the error terms are each 0.000. There is modest covariance among the contemporaneous regressors, summarised in Table 12. The highest correlation is -0.231 between liquidity and duration.

Table 12: Correlation Matrix of the Contemporaneous Variables

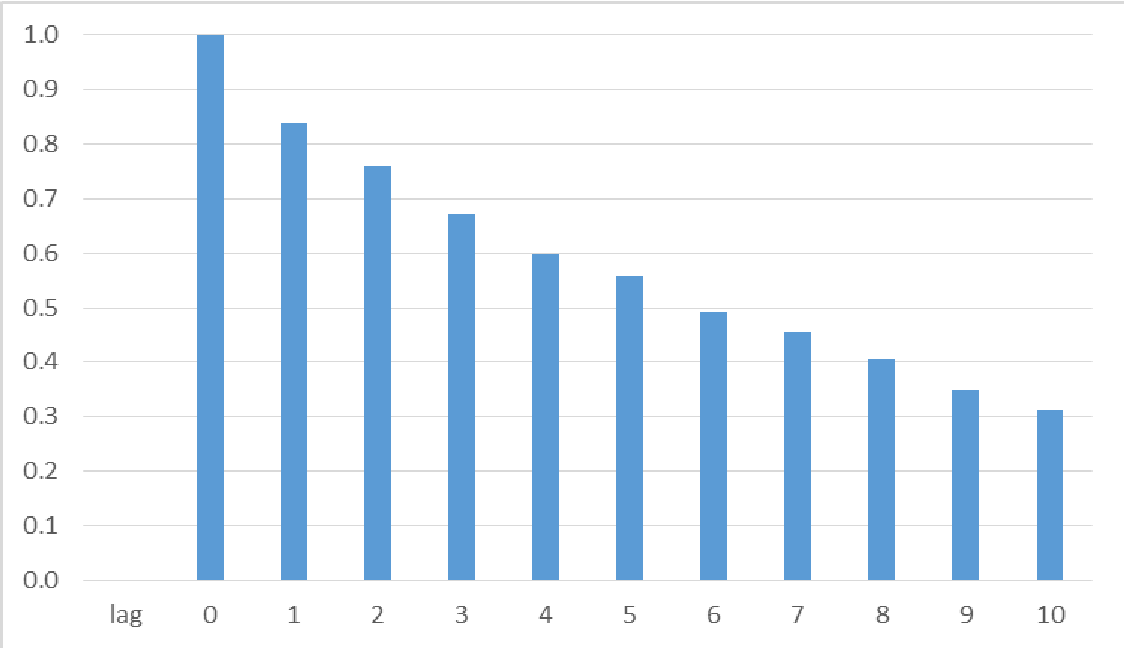
Correlation	Yield Spread	Coupon	Duration	Credit Rating	Liquidity
Yield Spread	1	0.314	0.284	0.379	-0.320
Coupon		1	0.216	0.109	-0.099
Duration			1	-0.088	-0.231
Credit rating				1	-0.174
Liquidity					1

Source: Calculated

Adding lags of the dependent variable as regressors

The specification of the OLS model is checked by comparing with models that include lags of the dependent variable as regressors. Yield spreads exhibit persistence over time and the residuals are highly correlated with each other, suggesting a possible misspecification of the regression model. The low Durbin-Watson statistic can be an indicator of autocorrelation of the residuals in Model 1. Figure 6, shows correlations of the residuals of the regression with the same residuals lagged by one period, and up to ten periods.

Figure 6: Correlation of the Residuals of Model 1



Source: Calculated

I address possible autocorrelation by adding one or more lags of the dependent variable to the list of contemporaneous regressors.

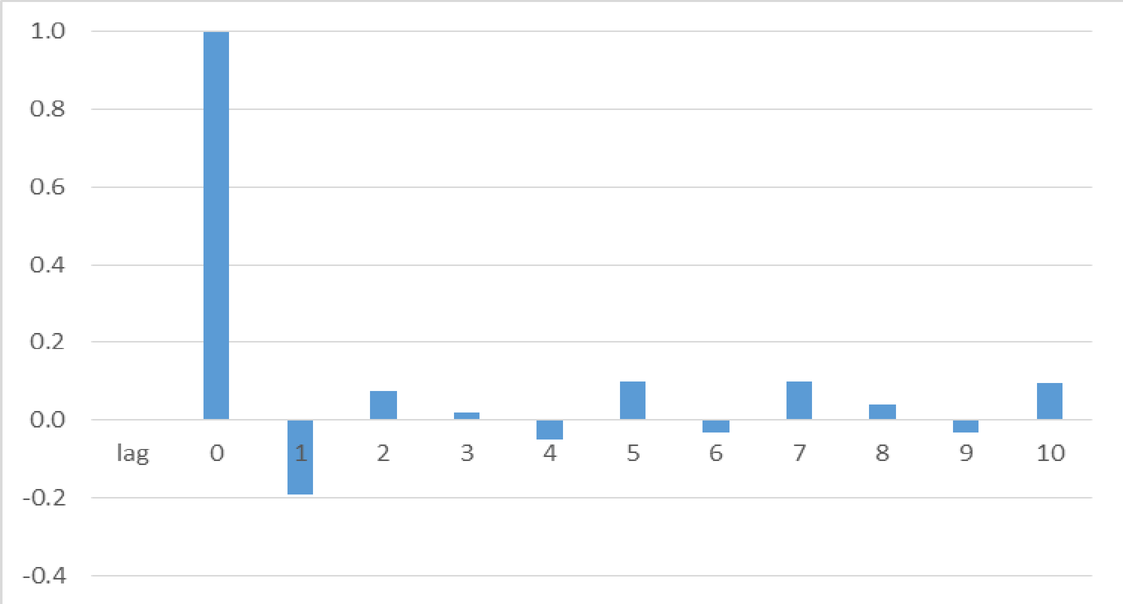
Table 13: How Many Lags of the Dependent Variable to Use?

Estimator	(1)	(2)	(3)	(3)	(3)	(3)
Constant	0.0455	0.0035	0.0009	0.0019	0.0374	0.1168 *
	(0.1162)	(0.0177)	(0.0150)	(0.0369)	(0.0187)	(0.0485)
Liquidity (per €bn)	-0.0854 **	-0.0155 **	-0.0143 **	-0.0138 **	-0.0173 **	-0.0210 **
	(0.0332)	(0.0060)	(0.0054)	(0.0050)	(0.0059)	(0.0070)
Duration	0.0196 *	0.0034 *	0.0031 *	0.0033 **	0.0044 **	0.0058 **
	(0.0085)	(0.0015)	(0.0013)	(0.0012)	(0.0016)	(0.0023)
Coupon	0.0692 ***	0.0102 **	0.0083 ***	0.0081 **	0.0074 **	0.0060 **
	(0.0131)	(0.0040)	(0.0026)	(0.0029)	(0.0024)	(0.0022)
Credit rating	0.2604 **	0.0284 *	0.0182	0.0244 *	0.0132	-0.0147
	(0.0769)	(0.0133)	(0.0108)	(0.0104)	(0.0114)	(0.0101)
Yield spread with one lag		0.8638 ***	0.6607 ***	0.6413 ***	0.6423 ***	0.5976 ***
		(0.0493)	(0.0537)	(0.0425)	(0.0566)	(0.0497)
Yield spread with two lags			0.2338 ***	0.2404 ***	0.2192 ***	0.1952 ***
			(0.0287)	(0.0366)	(0.0270)	(0.0377)
Time fixed effects	No	No	No	Yes	No	Yes
Issuer fixed effects	No	No	No	No	Yes	Yes
number of observations	2856	2786	2717	2717	2717	2717
number of bonds	70	70	69	69	69	69
number of time periods	73	72	71	71	71	71
R-squared	0.320	0.833	0.842	0.870	0.843	0.875

Source: Calculated; cluster robust standard errors; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

OLS regression results of a one lag model without fixed effects are represented by Model 2 in Table 13. An Augmented Dickey Fuller test rejects the null hypothesis of a unit root, with a t-statistic of -8.33 and an associated one-sided p-value of 0.00. The R-squared is improved relative to Model 1. This comes at the cost of reduced coefficients of all the original contemporaneous regressors, although each remains significant at least at the 10% level and their signs remain the same between Model 1 and Model 2. The size of each of the coefficients of coupon, liquidity, duration and credit rating is reduced by at least 74% relative to Model 1, while the coefficient of the lagged variable is highly significant. Figure 7 shows that adding a one-period lagged observation of the dependent variable to the existing regressors reduces, but does not entirely eliminate the residuals' autocorrelation. Fixed effects results for the one lag model are published in Table 11.

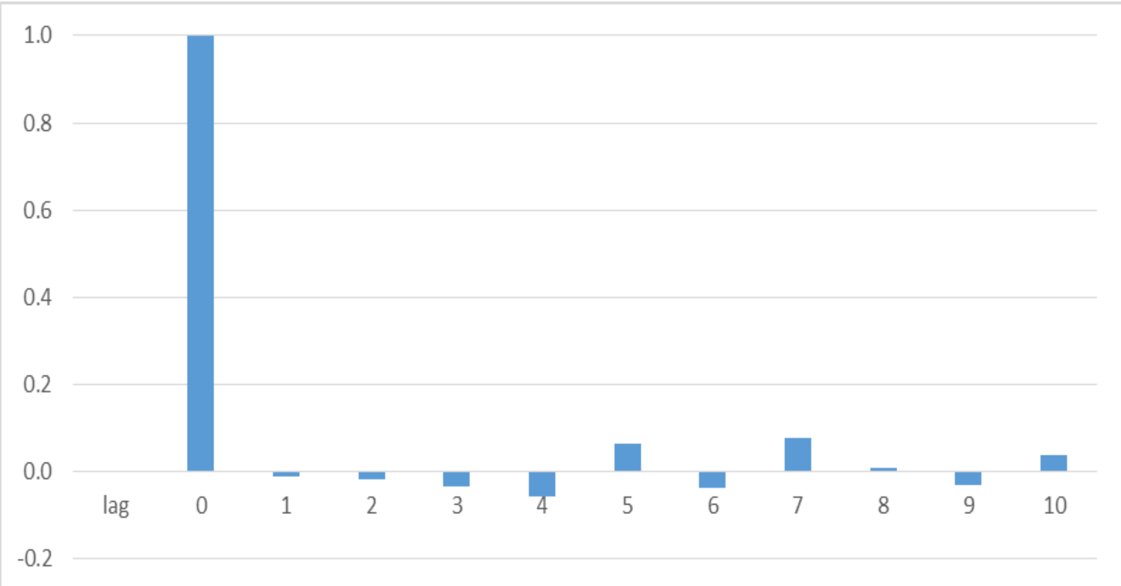
Figure 7: Correlation of Residuals with One Lag Added to the Regressors



Source: Calculated

Table 13 also shows results of OLS regression models that include two lags of the dependent variable (Model 3). As Figure 8 shows, the serial correlation of the regression residuals is effectively eliminated in a model that includes two lags of the dependent variable as an additional regressor. While there is a small improvement in the R-squareds of the models with two lags of the dependent variable as regressors, credit rating loses significance as a regressor in three of the four models. Only liquidity and coupon remain significant at least at the 5% level in all two-lag models, with and without fixed effects.

Figure 8: Correlation of Residuals with Two Lags Added to the Regressors



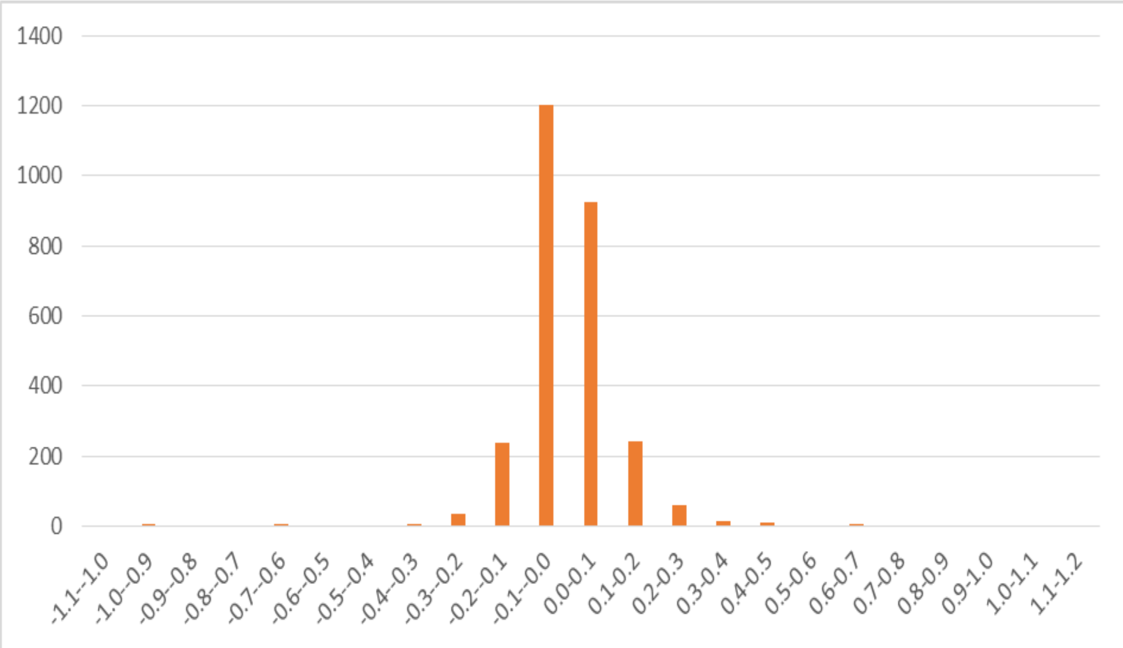
Source: Calculated

In summary, there is a trade-off in models with lags of the dependent variable as a regressor between reduced risk of bias in the estimator against lower or lost significance of regressors of interest. The addition of fixed effects improves the R-squareds of the regressions in both the one-lag and two-lag models. However, inclusion of issuer fixed effects in these models leads to loss of significance of the credit rating regressor. All contemporaneous variables are significant at least at the 10% level in time fixed effects models.

Distribution of residuals

Jarque-Barra test statistics reject the null hypothesis of normally distributed residuals of Model 2. Figure 9 shows negative skewness and kurtosis of the residuals.

Figure 9: Distribution of the Residuals within Model 2 Estimation



Source: Calculated; the x-axis shows the ranges of the 2,786 observations; the y-axis measures frequency of observations

Tests for heteroscedasticity are generally invalidated when there is serial correlation across the residuals, as is the case in Model 1. Instead, I look at heteroscedasticity in a model that includes one lag of the dependent variable. A Breusch-Pagan test rejects the null hypothesis of constant variance of the residuals. I also discuss on page 67 panel regressions that are undertaken by Generalised Least Squares to allow for heteroscedasticity and/or serial correlation of residuals.

Model bias

While the regressors of interest within Model 1 are all significant, the R-squared of this model is modest and the error terms exhibit heteroscedasticity and serial correlation. Introducing time-lags of the dependent variable (bond yield spread) into the model's explanatory variables creates a dynamic panel data model. The model's R-squared improves and the lagged dependent variable regressors are more significant within the model than the contemporaneous variables. However, the lags of the dependent variable in Model 2 correlate with the error term with a coefficient of 0.27. Therefore, OLS estimators may be inconsistent, which raises the possibility of bias.

The argument in favour of using OLS in dynamic panel data models rests on the size of T (time) and the coefficient of the lagged dependent variable, ρ. Nickell (1981) studies standard models for the first-order autoregressive case and finds that bias in dynamic models with fixed effects falls as a function of $1/T$.

Nickell shows that 'for reasonably large values' of T, the following approximation holds:

$$\underset{N\to\infty}{Plim}\,(\hat{\rho}-\rho) \approx \frac{-(1+\rho)}{T-1}$$

My panel data contain 73 time periods and in Model 2 without fixed effects ρ = 0.86, which implies the upper bound of the absolute bias is 0.026.
On the other hand, Beck and Katz (2004) conclude that the Nickell bias has already fallen as low as 0.02 when T = 20.

Clustering of standard errors

Clustering of errors can lead to overstating the significance of results. Following Cameron and Miller (2015), I use cluster robust standard errors in the main regression analysis, clustering about the MBA issuers by month. Cluster robust standard errors are greater than heteroscedasticity-adjusted standard errors, so the significance of the regressors of interest is lower than estimations that use other standard errors. Looking at individual issuers, the greatest absolute average residuals of Model 2 are found within observations for MuniFin (mean -3.39 basis points) and Kommuninvest (mean 2.77 basis points). But Model 2 generates the best regression fit to the overall panel data, not to sub-samples of the individual issuers. I would expect the average errors of the fitted data to be higher for some issuers and lower for others.

Table 14: Residuals of Model 2 by Issuer

	BNG	NWB	Muni Fin	KBN	Kommune kredit	Kommun invest	Total
Mean	-0.0047	-0.0095	-0.0339	0.0055	0.0132	0.0277	0.0000
Median	-0.0071	-0.0103	-0.0446	-0.0179	0.0140	0.0161	-0.0078
Standard Deviation	0.0835	0.1006	0.2771	0.1384	0.2164	0.0922	0.1338
Skewness	0.9471	0.8532	0.7572	2.1635	-0.5154	0.6036	0.7307
Kurtosis	7.7042	36.3349	7.9274	9.4594	3.5060	1.1097	20.6839

Source: Calculated

OLS models compare well to GLS and Instrumental Variables

None of the four contemporaneous variables correlate with the error term within the main OLS regressions. Nonetheless, I set up a Two Stage Least Squares estimation model to investigate consistent estimates of the dependent variable. I instrument the explanatory variables by the same variables with a one period lag. The 2SLS results are represented as Model 4 within Table 15, which I compare to the OLS model that includes one lag of the dependent variable. The R-squared of the 2SLS model is similar to that of the OLS model.

Table 15: Regressions with Instrumental Variables and GLS

Estimator	OLS	2SLS	2SLS with Time Fixed Effects	GLS with Cross-Section Weights	GLS with Time Weights
	(2)	(4)	(4)	(5)	(5)
Constant	0.0035	-0.0016	0.0005	0.0014	0.0076
	(0.0107)	(0.0112)	(0.0206)	(0.0111)	(0.0067)
Liquidity (per €bn)	-0.0155 ***	-0.0104 ***	-0.0094 *	-0.0116 ***	-0.0119 ***
	(0.0034)	(0.0036)	(0.0054)	(0.0036)	(0.0025)
Duration	0.0034 ***	0.0024 ***	0.0023	0.0019 **	0.0028 ***
	(0.0009)	(0.0009)	(0.0014)	(0.0009)	(0.0007)
Coupon	0.0102 ***	0.0053	0.0051	0.0077 ***	0.0038 *
	(0.0031)	(0.0033)	(0.0042)	(0.0020)	(0.0023)
Credit rating	0.0284 ***	0.0145 **	0.0147	0.0130	0.0083 **
	(0.0064)	(0.0067)	(0.0130)	(0.0102)	(0.0035)
Yield spread with one lag	0.8638 ***	0.9281 ***	0.9251 ***	0.9133 ***	0.9070 ***
	(0.0167)	(0.0181)	(0.0300)	(0.0177)	(0.0099)
Number of observations	2786	2716	2716	2772	2772
Number of bonds	70	69	69	70	70
Number of time periods	72	71	71	72	72
R-squared	0.833	0.831	0.860	0.926	0.922

Source: Calculated; White-Huber robust standard errors; *** p<0.01, ** p<0.05, * p<0.1

In order to underline the loss of significance of regressors as I move from Model 2 to Model 4, I present both models with White-Huber heteroscedasticity-consistent standard errors, which differs from the cluster-robust standard errors presentation of results in Tables 11 and 13. Coupon loses significance in the 2SLS model. Liquidity and duration remain significant at the 1% level, although their respective coefficients are somewhat smaller than those represented within the OLS model. Only liquidity remains significant within the 2SLS model with period fixed effects, that is at the 10% level. The coefficients of the lag of the dependent variable in 2SLS models are higher than those of OLS.

For further robustness in the presence of autocorrelation and heteroscedasticity of the residuals in the OLS model, I construct Generalised Least Squares (GLS) estimates, which I include within Table 15 as Model 5. The R-squareds are higher than those achieved with an OLS approach, but there is some loss of significance of regressors. The coefficients of all the contemporaneous variables are much lower than those within the OLS models, while the coefficients of the lag of the dependent variable are higher than those of OLS.

The choice between an OLS and instrumental variables approach to modelling this panel is a trade-off between bias in the least squares estimator and a loss of significance of the contemporaneous variables in the 2SLS model. Following Beck and Katz (2004), I adopt the OLS model with fixed effects, including one lag of the dependent variable as a regressor, as the best linear regression model.

Does investor tax status drive the significance of coupon?

Coupon is a significant regressor in all of the OLS models, although it loses significance in the 2SLS models. In all OLS models the coefficient is positive, suggesting that yield spread rises as coupon increases. The literature offers some guidance: Schaefer (1982) shows a relationship between bonds' tax clienteles by the percentage of a bond's total return that arises in the form of coupon income relative to capital gain (for example, higher tax investors buy lower coupon bonds and low tax payers buy higher coupon bonds). Elton et al. (2001) argue that because coupon is higher for lower-rated debt, then the tax burden is higher, which suggests a tax effect.

I compare the highest tax rates of investment income and capital gains across the different jurisdictions of the bond agencies, to investigate whether the tax status of different investors affects the relationship between coupon and yield spread. Table 16 highlights the approximate share of investors in all municipal bond types, domestic and foreign currency. While central banks are not motivated by tax, it is possible that other investor types are. In addition to private individuals, many asset management funds are pooled funds with individual unit holders, which may prioritise income or capital growth.

Table 16: Share of Investment by Different Investor Types

	Central Banks	Asset Managers	Individuals	Banks	Other
BNG	34%	22%	1%	22%	21% *
KBN	n/a	n/a	n/a	n/a	n/a
Kommunekredit	n/a	n/a	n/a	n/a	n/a
Kommuninvest	60%	6%	6%	26%	2% **
MuniFin	29%	10%	37%	19%	5%
NWB	15%	25%	4%	42%	14% ***

Source: municipal bond agencies 2016 annual reports; * 9% official institutions, 9% insurers, 2% pension funds, 1% corporates; ** other is corporates; *** other divides between insurance/pension funds

I look at the taxation of investment income and capital gains of individuals rather than companies, because capital gain is often seen as part of the normal operations of a company and therefore subject to tax at the same marginal rate as investment income. Investment income tax may be levied at a flat rate (as in Netherlands, Norway and Sweden) or a progressive rate (for example, Denmark, Finland). In Denmark, share dividends and capital gains are taxed from 36.5% up to 42%, depending on income level, while other types of investment income (such as bond interest) are taxed within the ordinary personal tax scheme. In Finland, investment income tax rises from 30% to a top rate of 34%.

Table 17: Top Domestic Rate of Investment Income Tax

	2010	2011	2012	2013	2014	2015
Denmark	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%
Finland	30.0%	28.0%	32.0%	32.0%	32.0%	34.0%
Netherlands	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
Norway	28.0%	28.0%	28.0%	28.0%	27.0%	25.0%
Sweden	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
United Kingdom	50.0%	50.0%	50.0%	45.0%	45.0%	45.0%

Source: Deloitte, Grant Thornton, KPMG, pwc, Expatax, Trading Economics, HMRC

Contrasting Table 17 with the marginal rate of capital gains tax for each country in Table 18, it is apparent that the rate of investment income tax is closely aligned with the rate of capital gains tax across the Nordic countries (the rates are the same, although some tax bands may vary). Thus, the high tax-rate private investor should be indifferent between investment income and capital gain. However, the story is different in the Netherlands, where capital gains are generally exempt from tax. In that case capital gain is considered to be income from 'other activities' or 'business income' and is taxed accordingly. The UK also levies capital gains tax at a different (lower) rate to investment income tax.

Table 18: Top Domestic Rate of Capital Gains Tax

Country	2010	2011	2012	2013	2014	2015
Denmark	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%
Finland	30.0%	28.0%	32.0%	32.0%	32.0%	34.0%
Netherlands	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Norway	28.0%	28.0%	28.0%	28.0%	27.0%	25.0%
Sweden	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
United Kingdom	28.0%	28.0%	28.0%	28.0%	28.0%	28.0%

Source: Deloitte, Grant Thornton, KPMG, pwc, Expatax, Trading Economics, HMRC

To investigate the coupon effect, I interact coupon with the country regressors and check for significance within the resulting regressions. I use a dummy (NL) for the Netherlands, as I am testing for the country effect. The results in Table 19 show that the coupon effect is strongest in Norway and Sweden and weakest in Finland and the Netherlands. In Model 2, the coupon x issuer dummy loses significance either partially or completely relative to coupon in Model 1 in all countries. In Model 4, in which yield spread is regressed on just coupon, only coupon x Finland and coupon x Netherlands lose significance relative to coupon in Model 3. In Model 6, which regresses yield spread on coupon and a lagged dependent variable, all coupon x country dummy regressors lose/reduce significance relative to Model 5 coupon.

Table 19: OLS Regressions with Coupon Interacting with Country Dummies

Estimator	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.0035	0.0213	0.1920 **	0.2560 **	0.0110	0.0227
	(0.0177)	(0.0126)	(0.0684)	(0.0900)	(0.0131)	(0.0186)
Liquidity (per €bn)	-0.0155 **	-0.0172 **				
	(0.0060)	(0.0060)				
Duration	0.0034 *	0.0057 **				
	(0.0015)	(0.0022)				
Credit rating	0.0284 *	0.0246				
	(0.0133)	(0.0141)				
Coupon	0.0102 **		0.1038 ***		0.0119 **	
	(0.0040)		(0.0215)		(0.0044)	
Coupon x DEN dummy		0.0125		0.1245 ***		0.0189 *
		(0.0068)		(0.0305)		(0.0083)
Coupon x FIN dummy		-0.0096 *		0.0167		0.0027
		(0.0044)		(0.0330)		(0.0052)
Coupon x NL dummy		0.0039		0.0552 *		0.0088
		(0.0058)		(0.0273)		(0.0053)
Coupon x NOR dummy		0.0130 *		0.1068 ***		0.0148 *
		(0.0052)		(0.0265)		(0.0070)
Coupon x SWE dummy		0.0196 *		0.1512 ***		0.0194 *
		(0.0084)		(0.0242)		(0.0089)
Yield spread with one lag	0.8638 ***	0.8244 ***			0.8986 ***	0.8756 ***
	(0.0493)	(0.0597)			(0.0437)	(0.0517)
Number of observations	2786	2786	2856	2856	2786	2786
Number of bonds	70	70	70	70	70	70
Number of time periods	72	72	73	73	72	72
R-squared	0.833	0.837	0.099	0.274	0.829	0.831

Source: Calculated; cluster robust standard errors; *** p<0.01, ** p<0.05, * p<0.1

Can Euro Area issuers issue more cheaply than non-Euro Area issuers?

The sample includes issuers from four different currencies. Three are based within the Euro Area (MuniFin, BNG and NWB) and the domestic currencies of the others are Danish krone, Norwegian krone and Swedish krone. In order to investigate whether there is a currency advantage for issuers from a particular currency bloc, I look at the issuer fixed effects dummies of Model 2 with issuer fixed effects from Table 11. One of the issuer parameters is excluded, in order to avoid collinearity between the control variables. The results of Table 20 underline the impact of issuer effects. The horizontal axis highlights the dummy variable that is excluded and the vertical axis shows the resulting coefficients of the other dummy variables. When one of the Danish, Norwegian and Swedish dummy variables are excluded, the coefficients of the Finnish and Dutch dummies are always negative. The yield spread depends negatively on the Euro Area dummies. This suggests that the Euro Area issuers are able to issue more cheaply than the non-Euro Area issuers.

Table 20: Parameter Coefficients of the Issuer Fixed Effects Dummies of Model 2

	DEN	FIN	NLB	NLN	NOR	SWE
DEN		0.0565	0.0265	0.0302	0.0024	-0.0260
FIN	***-0.0565***		-0.0300	-0.0263	***-0.0541***	***-0.0825***
NLB	***-0.0265***	0.0300		0.0037	***-0.0240***	***-0.0525***
NLN	***-0.0302***	0.0263	-0.0037		***-0.0277***	***-0.0562***
NOR	-0.0024	0.0541	0.0240	0.0277		-0.0285
SWE	0.0260	0.0825	0.0525	0.0562	0.0285	

Source: Calculated, key DEN – Denmark, FIN – Finland, NLB – Netherlands (BNG), NLN – Netherlands (NWB), NOR – Norway, SWE - Sweden

While Table 5 shows that the three Euro Area municipal bond issuers command lower yield spreads than the other three issuers, we should not consider issuer effects in isolation, but consider other regressors, such as duration and bond liquidity.

Robustness checks

Table 21 includes results of models with different control regressors. Model 2 of Table 13 is used as the base model, which includes a one-period lag of the dependent variable and no fixed effects.

1. Price returns and variance of price returns as a proxy for liquidity

In the literature review, price returns are discussed as a proxy of liquidity. I observe prices at monthly intervals for issued municipal bonds and construct price returns as an instrument for the liquidity regressor. This is included in Model 7 in Table 21. This regressor is not significant and the model's overall results are similar to those of Model 2. Thus, Model 2 offers a clearer economic interpretation of yield spread as a function of outstanding issuance than Model 7's yield spread as a function of price return. I also study variance of price returns (not reported). I find that this regressor is significant at the 10% level and the R-squared of this model is slightly reduced relative to Model 2. The coefficients of the other variables are otherwise similar to those of Model 2.

2. Change in issuance outstanding as an instrument for liquidity

I investigate the month-to-month change in the euro value of issuance outstanding as an alternative measure to the actual euro value outstanding (results not reported). In terms of fit, the resulting regression is similar to Model 2, with an R-squared of 0.833. However, the change in issuance outstanding coefficient is not significant. There are large monthly changes in some of the Swedish data, relative to other bond time series. All other regressors are similar to those in Model 2.

3. Proximity to a benchmark sovereign bond

Kommuninvest, BNG, NWB and MuniFin support benchmark municipal bond programmes in their respective domestic currencies. In general, the bond issuance of European municipal bond issuers is pitched close to existing benchmark bonds of their respective sovereign issuers. For example, of the 2,856 domestic bond observations in my sample, the time-to-maturity of 67.3% of them are within six months of the closest sovereign benchmark bond. I add the absolute of distance in years from the closest sovereign benchmark bond to the list of contemporaneous regressors, to understand the effect of a bond's proximity to a sovereign benchmark bond on its yield spread to the sovereign curve. Within the regression without lags of the dependent variable (not reported in Table 21), the regressor is significant at the 10% level. But this coefficient is negative. Once I add lags of the dependent variable to the regression (see Model 8 in Table 21), the 'absolute of distance' variable loses significance. Many MBAs maintain their own benchmark bonds in domestic currency.

4. Time-to-Maturity

I include bond duration ahead of time-to-maturity in my models, given the improved results gained. Had I followed Namvar et al. (2015) and used time-to-maturity instead of duration in Model 1 of Table 11, this would have kept all regressors significant at least at the 10% level (results not reported). However, the R-squared of the regression fell to 0.266. Including time-to-maturity in Model 2, which includes a lag of the dependent variable as a regressor, generates very similar results to those shown in OLS(2) in Table 21. All parameters remain significant at least at the 10% level.

5. Risk appetite

Changing market risk appetite regimes may influence what an investor is willing to pay for an asset, all else being equal. Barrios et al. (2009) investigate the impact of different investor risk appetite regimes on the time persistence of yield spreads. They introduce a global markets risk factor into their model, which they proxy by log (VIX), where the VIX index represents the CBOE Volatility Index, a measure of the implied volatility of S&P 500 index options. Following Barrios et al., I include the VIX index as an instrument within Model 9 in Table 21. Comparing the results with Model 2 shows coefficients of the contemporaneous regressors are similar in general. I also test the VDAX index and the implied volatilities of the S&P 500 and Euro STOXX 50 indices as instruments and generate similar results (not reported). The VIX index correlates with the residuals of the OLS regression with a coefficient of 0.409. I find similar results by measuring correlations of the residuals with other proxies for investor risk appetite, such as the VDAX index and 3-month implied volatility of equity indices, such as the DAX 30. Time fixed effects capture the influence of aggregate time trends, so risk appetite controls may not be necessary in models with time fixed effects. Indeed, the correlation between the VIX index monthly time series and the time fixed effects from a time fixed effects model is a relatively high 0.454.

Table 21: Robustness Checks

Estimator	OLS (2)	OLS with price return (7)	OLS with proximity to benchmark bond (8)	OLS with risk appetite (9)
Constant	0.0035	-0.0149	0.0028	-0.0531 *
	(0.0177)	(0.0083)	(0.0178)	(0.0238)
Liquidity (per €bn)	-0.0155 **	-	-0.0167 **	-0.0171 *
	(0.0060)		(0.0064)	(0.0073)
Duration	0.0034 *	0.0043 **	0.0042	0.0033 *
	(0.0015)	(0.0014)	(0.0022)	(0.0015)
Coupon	0.0102 **	0.0089 **	0.0105 *	0.0101 *
	(0.0040)	(0.0026)	(0.0045)	(0.0043)
Credit rating	0.0284 *	0.0267 *	0.0295 *	0.0234
	(0.0133)	(0.0130)	(0.0142)	(0.0136)
VIX index	-	-	-	0.0040 ***
				(0.0003)
Price return	-	-0.0161	-	-
		(0.0123)		
Proximity to benchmark bond	-	-	-0.0065	-
			(0.0065)	
One lag of yield spread	0.8638 ***	0.8839 ***	0.8612 ***	0.8488 ***
	(0.0493)	(0.0433)	(0.0511)	(0.0507)
Number of observations	2786	2786	2786	2786
Number of bonds	70	69	70	70
Number of time periods	72	72	72	72
R-squared	0.833	0.837	0.833	0.837

Source: Calculated; cluster robust standard errors; *** p<0.01, ** p<0.05, * p<0.1

CONCLUDING REMARKS

This chapter provides the first analysis of the secondary market performance of the bond issuance of all the six major European MBAs. I demonstrate that there is an interest cost saving case for a new UK municipal bond agency. However, history shows that MBAs have only proved successful in a small number of developed countries. Their excellent long-term records of avoiding credit distress and default are reflected in strong credit ratings and competitive loan pricing for their member SNGs. But this business model is not universally adopted.

The UKMBA must compete against a strong incumbent loans company, which is 100% owned by central government and is the dominant force in the UK market for local authority long-term funding. Subject to the limitations of synthetic control methodology in this investigation, the results suggest that the bond issues of a synthetic UK MBA can generate interest cost savings relative to a synthetic PWLB bond issuer. That said, the actual PWLB does not rely upon a bond issuing model for funding and any local authority borrower can draw funds from it at a predetermined spread over the UK par gilt curve on demand. Recent evidence shows that PWLB loan pricing is responsive to competitive threats, including from the UKMBA (see the Summary and Contribution of the Thesis). This implies that the UKMBA has a high hurdle to clear in order to establish a sustainable business.

In terms of planning bond issuance, European MBA bond yield spreads depend negatively on liquidity and positively on duration. I show that the yield spread rises by 0.64 basis points per year of duration in models with lag regressors and fixed effects. This is economically significant for an MBA bond issuer that plans bond issuance with a term in excess of 10 years, which is where much of current lending to English and Welsh local authorities is focused. A caveat to this result is that there are limited European MBA bond data of longer duration to guide policy, due to a lack of suitable, observable bonds. Only 15.6% of the observations in the regression sample have a duration of more than 10 years.

APPENDIX

Estimating a yield curve by the Nelson-Siegel-Svensson method

The EFFAS-European Bond Commission published 'Overview of Methodology for Definition of Risk Free Zero-coupon Yield Curve and Spreads in the Eurozone' (June 2006) and the Monetary and Economic Department of the Bank of International Settlements published 'Zero-coupon Yield Curves: Technical Documentation' (October 2005). These highlight that the Nelson-Siegel-Svensson method is one of a number of methods used by central banks and private sector institutions to estimate a yield curve from bond data. The former paper also discusses parametric models and spline-based models to estimate zero-coupon yield curves and describes the different processes used by 13 central banks across developed markets. The BIS Paper contains a detailed definition of the Nelson-Siegel method (1987) and the Svensson extension (1994). The extended Nelson–Siegel-Svensson model can offer an improved curve fit to the data and smoother shape over the Nelson–Siegel curve, which has fewer parameters. On the other hand, the model can struggle with irregular yield curves.

The yield of a zero-coupon bond of n years' maturity is the true n-year interest rate. A zero-coupon yield curve estimates the term structure of interest rates and provides a common reference point to estimate the present value of money. Model parameters are determined by minimisation of the squared deviations of theoretical yields from observed yields to give the result in Figure 10.

τ represents time-to-maturity. For longer maturities, the spot and forward rates asymptotically converge to β_0, which will be positive. β_1 is the slope of the curve. The parameters β_2 and τ_1 define the first hump in the curve – the magnitude of the hump is determined by the absolute value of β_2; its direction is determined by the sign of β_2 (a negative derives a u-shape, a positive derives a hump or inverse u-shape); τ_1 determines the position of the hump.

The Svensson extension to a Nelson-Siegel curve adds the extra parameters, β_3 and τ_2, which allow for a second hump.

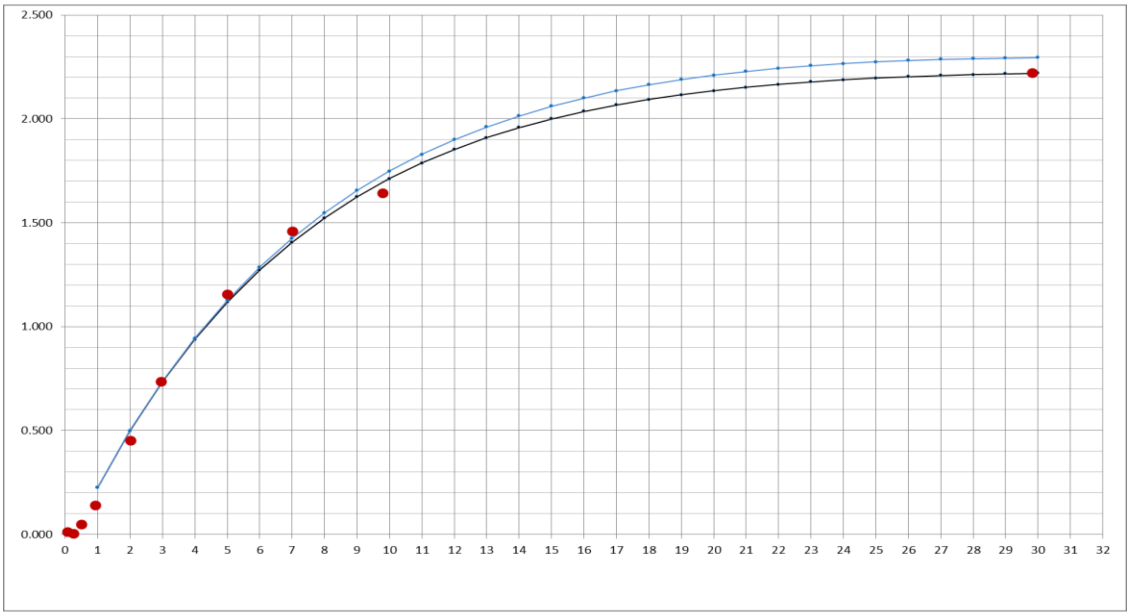
Figure 10: The Nelson-Siegel-Svensson Curve Fitting Formula

$$y(\tau) = \beta_0 + \beta_1\left(\frac{1-e^{\frac{-\tau}{\tau_1}}}{\frac{\tau}{\tau_1}}\right) + \beta_2\left(\frac{1-e^{\frac{-\tau}{\tau_1}}}{\frac{\tau}{\tau_1}} - e^{\frac{-\tau}{\tau_1}}\right) + \beta_3\left(\frac{1-e^{\frac{-\tau}{\tau_2}}}{\frac{\tau}{\tau_2}} - e^{\frac{-\tau}{\tau_2}}\right)$$

Source: Nelson, Siegel and Svensson; Key: $y(\tau)$ is yield to maturity; τ is time; the vectors β_0, β_1, β_2, β_3, τ_1 and τ_2 are the parameters to be estimated, with (β_0, τ_1 and τ_2) > 0; β_0 is the long-term yield; β_1 is the slope of the curve; β_2 is the curvature; β_3 is the secondary slope; τ_1 and τ_2 represent time decay

Figure 11 shows an example of a zero-coupon government yield curve, as derived by the Nelson-Siegel-Svensson process. It sits alongside the coupon-paying par yield curve. In this example there are 15 benchmark bonds, but this number might vary from month to month. Most government yield curves are generated from between 8 and 15 government benchmark bonds.

Figure 11: A Representative US Treasury Bond Yield Curve (January 2015)



Source: Bloomberg, Nelson, Siegel and Svensson; x-axis is time (years), y-axis is yield-to-maturity
Key: red dots – current bond yields of the yield curve constituent bonds; black line – the fitted par curve; blue line – the fitted zero-coupon curve

The upward sloping zero-coupon yield curve is normally above the par yield curve. A few yield curves are sparsely populated by benchmark bonds at the longer maturity end of the spectrum, which can lead to a small number of fitted yield curves turning sharply downwards or diverging to high yields at the longer end. Given that MBAs use foreign exchange swaps to hedge short-dated bonds that are issued with less than one year's life, I do not use municipal bonds curves for less than one year duration in this analysis.

I acknowledge the advice of Professor Lars Svensson of Stockholm University and Seppo Orjasniemi of the Bank of Finland in creating the curves that are relevant for my analysis.

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CHAPTER 2: THE VALUE OF PARTICIPATION IN A MUNICIPAL BOND BANK

Abstract

What determines whether a municipality issues its own bonds or participates in a mutual credit-pooling agency's issuing activity? The US offers most scope for comparisons. The US municipal bond market includes individual municipalities and credit-pooling agencies, known as municipal bond banks (MBBs). Nine of the ten MBBs enjoy an implicit guarantee from their respective State and over time they have all built a reserve within their respective balance sheets that acts as a buffer against individual municipality financial stress. I show that an individual municipality's credit rating and required bond participation size affect its probability of joining MBB bond issuance. Furthermore, using propensity score matching, it is shown that participation in an MBB bond issue has a negative effect on interest rates for municipalities.

Keywords: Municipal bond bank; interest costs; yield spread

JEL Classification Numbers: G12, G21, H74

INTRODUCTION

Ang and Green (2013) argue that municipal bond issuers pay billions of dollars each year in unnecessary fees and interest expenses. Municipal bond markets are illiquid, with a lack of pricing transparency, and they operate inefficiently, raising costs for issuers. They propose the establishment of CommonMuni, an independent advisory firm to reduce borrowing costs for municipalities [7] and raise returns for investors. While this stops short of arguing the case for credit-pooling agencies, the recognition that bond pricing by individual US municipalities is inefficient in the largest municipal bond market in the world motivates my examination of the advantage of MBBs as a method of funding long-term municipality debt.

I address which of individual bond issues and credit-pooling agency bond issues is best suited for which municipalities. My research objective is twofold: to identify the factors driving a municipality's participation in a credit-pooling agency's bond issuance and to identify the interest cost advantage of a credit-pooling agency bond issuer to a municipality, relative to issuing its own bond. The first investigation is undertaken through probit regression of municipal bond bank bond participation on a participant's credit rating and bond participation size. The second investigation involves linear regressions and propensity score matching for treatment effects on a bond's yield spread from MBB bond participation.

The US market is used as the basis to assess these questions. The European municipal bond agencies (which are similar to MBBs) are so dominant in their respective countries that there are few individual domestic municipality bond issuers in these markets to compare them with. On the other hand, a US municipality can raise capital by individually issuing general obligation or revenue bonds. Alternatively, it can join a group of municipalities that participate in the bond issuance of a credit-pooling agency. MBBs and Municipal Finance Authorities issue bonds collectively on behalf of participating municipalities.

I compare the primary issuance of MBB bonds with those of individual municipalities, focusing on the five US States with the longest-standing MBBs, where I identify cross-sections of MBB and individual municipality bond issues. I include every municipal bond issued within these States over 2012-16. Much of the literature on pooled bond issuers is based on surveys and small data sets (Katzman, 1980; Kidwell and Rogowski, 1983;

[7] I refer to municipalities in this chapter, which are the most local tier of SNG in the US. These are the target market of the MBBs, rather than higher-tier SNGs, such as counties and State issuers

Gilbert and Pike, 1998). However, Municipal Securities Rulemaking Board (MSRB) data now allow creation of a multi-State data set, based on a detailed analysis of primary bond issues. A probit regression analysis allows me to identify key drivers of the decision of a municipality whether to issue its own bond or participate in the activity of an MBB.

I then calculate municipal bond to hypothetical MBB-curve yield spreads (defined on page 100) and select the best linear estimation model, which allows me to quantify the effect on yield spread of participation in an MBB bond issue plus control variables. OLS regressions give very significant results, but there may be a risk that the average causal effect of participating in the bond issues of an MBB is masked within the observed difference by a selection bias. I address this by using a propensity score matching method to refine the sample, using probit regressions on the key variable of interest.

To assess the other drivers of yield spreads, I refer to Kidwell and Rogowski (1983), Reid (1990) and Simonsen et al. (2001). They identify bond liquidity, duration, credit risk, the bond's tax exemption and underwriting agreement as drivers of municipal bond pricing. Larger bond issue sizes reduce underwriter costs per dollar of funds raised and increase the marketability of the bonds. Credit risks to investors are reduced by the pooling of beneficiaries, the standardisation of information available and a State's moral obligation to back the pooled bonds.

This paper creates a much larger and more detailed sample of bond and bond participant data from multiple sources compared to the small survey-based samples in the existing literature. This gives a more accurate input to my empirical work. This is also the first paper to use propensity score matching to refine the MBB participation samples.

The US Municipal Bond Bank Market

Many US municipalities, counties and States raise capital by issuing bonds, with a combined annual issuance of approximately US$390 billion (source: MSRB). To service smaller municipalities, some States have developed credit-pooling institutions that are similar to the European municipal bond agencies. There are ten Municipal Bond Banks and Municipal Finance Authorities across the USA. This is a small niche of the overall market, representing 0.5% of all US municipal bonds outstanding by value. Over 2012-16 their combined bond issuance averaged approximately US$800 million per annum.

The MBBs offer economies of scale, bond issuing expertise and strong balance sheets to participating municipalities. They use the proceeds of pooled bond issues to lend money to counties, cities, towns, school districts or other districts within their respective State.

The provision of funds is accomplished by the direct purchase from such municipalities of their bonds, notes or evidence of debt payable from taxes, charges for services or assessments. With the exception of the Indiana Bond Bank, which is structured as a quasi-government agency, the credit strength of the MBBs rests upon:

1) over-issuing pooled bonds by up to 10%, relative to the aggregate demand of municipalities, which is added to the MBB's balance sheet and invested in US Treasuries;

2) an implicit guarantee — normally a moral obligation — by their respective State to back all bonds in their pools in the event of default by a local issuer.

Table 22: List of US Municipal Bond Banks and Their Respective Launch Dates

Name of Municipal Bond Bank Authority	Date of Creation	Bonds outstanding over one year($billion)
Vermont Municipal Bond Bank	1969	0.53
Maine Municipal Bond Bank	1971	1.44
Alaska Municipal Bond Bank Authority	1975	1.03
North Dakota Public Finance Authority	1975	0.43
New Hampshire Municipal Bond Bank	1977	0.85
Virginia Resources Authority	1984	3.43
Indiana Bond Bank	1984	0.70
New Mexico Finance Authority (NMFA)	1992	1.17
Idaho Bond Bank Authority	2001	0.27
Michigan Finance Authority	2010	7.22

Source: MBB report & accounts; data at December 2016 or June 2017, depending upon authorities' respective year-ends; outstanding Indiana Bond Bank bonds and notes may not exceed $1 billion in aggregate by law

The reserve funds act as a line of defence in case an individual municipality defaults on its dues to the MBB. In addition, the implicit support of the State can take several forms. For example, in addition to a moral obligation, income from the State of New Mexico's 'Governmental Gross Receipt Tax' is directed to the NMFA as a credit enhancement of its bonds. The Idaho Bond Bank Authority states that 'The Bond Bank is able to pledge certain State funds as additional security for its bonds, further reducing interest costs.'

Municipal Bond Bank credit ratings

Moody's normal practice is to value the State obligation in isolation with a one-to-two notch discount relative to an MBB's respective State's credit rating. Other factors, including the MBB's balance sheet reserve fund, the MBB's long-term experience and good reputation may also contribute to the level of credit rating. In a discussion of a bond series issue by the New Hampshire Municipal Bond Bank on 9th May 2018, Moody's states '…for pool program structures that include a moral obligation pledge of their respective States to replenish a draw on the debt service reserve fund resulting from a loan repayment deficiency, we will compare the credit quality of the moral obligation pledge to the underlying pool program rating and apply the higher of the two.'

The credit experience of MBBs is excellent: none has ever reported a default. By contrast, US individual municipality bond default rates averaged 0.18% per annum across all issuers over 2007-16. Several MBBs purchase bond insurance though credit insurers, the cost of which is absorbed within the cost of bond issuance. Insurance premia vary from 10 basis points for AA-rated issues to more for lower rated bonds (reference Standard & Poor's ratings). Some MBBs have even built stronger or equal credit ratings relative to their respective State over time, as shown in Table 23:

Table 23: Credit Ratings of Municipal Bond Banks versus Their Respective States

Municipal Bond Bank Authority	Moody's credit rating	Respective State credit rating
Vermont Municipal Bond Bank	Aa1	Aaa
Maine Municipal Bond Bank	Aa2	Aa2
Alaska Municipal Bond Bank Authority	A1 *	Aa3
North Dakota Public Finance Authority	Aaa	Aa1
New Hampshire Municipal Bond Bank	Aa2	Aa1
Virginia Resources Authority	Aa2	Aaa
Indiana Bond Bank	AA+ **	Aaa
New Mexico Finance Authority	Aa1	Aa1
Idaho Bond Bank Authority	Aa1	Aa1
Michigan Finance Authority	Aa2	Aa1

Source: MSRB; data at December 2016; * Alaska Municipal Bond Bank Authority's lowest credit rating during 2012-16 was Aa3; ** this is the rating accorded by Standard & Poor's on the bond

Economic setting

I address which of primary market individual municipality bond issues or municipal credit-pooling agency-backed bond issues is best suited for municipalities by examining the relative trade-offs. A number of frictions raise the cost of issuing and trading individual bonds within the municipal bond market.

Individual municipal bond markets are illiquid – costs to issuers and investors

The tax exemptions on most US municipal bonds make them attractive to individuals. As a result, households held 66% of outstanding municipal bonds in 2018 directly or indirectly (i.e. through mutual funds), according to the Federal Reserve's flow of funds data. However, judged by the frequency of trading, most municipal bond markets are illiquid. The average municipal bond trades only twice per year (Ang et al., 2010). The direct costs of illiquidity to issuers include the fees paid to the bond underwriter and any difference between the reoffering price and the price at which bonds are sold to final investors. Trading costs for retail investors are over double those of institutions or dealers, which represent a large proportion of the first year's yield in transaction costs.

There are also indirect costs, such as the price concessions that must be made to an investor, who believes the bond may be difficult to sell in the future. In a liquid financial market, investors can buy and sell bonds at short notice and the price paid is relatively insensitive to the amount they wish to trade. However, in an illiquid market investors bear the risk that an unexpected need to sell their holdings might result in losses beyond those driven by fundamentals. Investors, concerned about their ability to sell efficiently in the future, will pay the issuer less for a bond today.

Individual municipal bond markets are opaque

Municipal bonds are not traded on centralised exchanges, but rather on over-the-counter (OTC) broker-dealer markets. On an exchange, quotations are publicly posted, and all trades are reported through a central clearing house. This reduces the cost of comparison shopping and search costs. By contrast, OTC prices are not available in a central location and comparison shopping involves a costly search. However, the MSRB now mandates that broker-dealers record their trades centrally and make these records available to the public. An investor can now see if the price she paid is out of line with prices paid by other investors from other recent trades. Nevertheless, the opacity of the OTC market places retail investors at a disadvantage relative to institutional investors and broker-dealers.

Information asymmetry in individual municipal bond markets

Municipal bond prices respond slowly to changes in market information, interest rate movements or macroeconomic announcements and adjustment in municipal bond prices can take days. Investors pay less for investments that carry non-transparent risks. The absence of timely financial information about a borrower adds adverse selection risk. In this case, investors must be concerned not just about the risk of the underlying credit, but also that the seller has private information. Thus, an investor may demand more advantageous prices to overcome these risks, further raising costs to the bond issuer.

The US municipal bond issuers are a large and diverse group, comprising over 50,000 entities. This heterogeneity limits information flow, because of fixed costs of gathering information, and inhibits liquidity by reducing the probability of a coincidence of needs between buyer and seller at any time. Municipal bond investors lack access to uniform standards of information disclosure and flow. Government accounting standards provide less transparency than their corporate counterparts, and compliance requirements vary by State. Financial reports from municipalities are released with lags after the close of their fiscal years and are rarely available in a format that can be easily compared across municipalities and time. The lack of a central source of information on the financial situation of individual issuers, the costs of attached derivatives, fees in debt issues and net issuing costs make it difficult for individual investors to make well-informed investment decisions. Furthermore, when municipalities negotiate with financial intermediaries to issue debt, they often have less expertise and relatively few resources to guide their decision-making. This is detrimental not only to investors, but also to the municipalities.

According to Ang and Green (2013), access to information in municipal bond markets and liquidity in trading involve externalities and other forms of market failure, namely:

• Standardisation and dissemination of financial information are public goods, which facilitates comparisons across different bonds, issued by different entities. It is more efficient that each issuer reports to a central information depository, accessible to all investors, than for each investor to approach each issuer with information requests.

• Finding information is costly. Investors face search and information acquisition costs that increase with added complexity and non-standardisation of securities.

• Opacity and complexity in certain financial instruments that bonds are wrapped into may reduce market competition and make it more difficult for investors and issuers to evaluate fees and other forms of compensation being earned by financial intermediaries. More standard municipal bond types are more liquid.

• Market liquidity is increasing in the number of market participants. The ease with which an investor can find a counterparty to trade with at mutually beneficial terms depends on how many people come to trade at a given time.

Pros and cons of the credit-pooling of Municipal Bond Banks

Municipal bond banks (MBBs) address a number of these issues, in particular for smaller municipalities. The credit rating spread between the State and the stand-alone municipality plays an important role in whether a municipal bond bank can help a municipality reduce its borrowing costs. Smaller communities with poorer credit ratings benefit the most, when issuing debt through MBBs (Katzman, 1980; Cole and Millar, 1982; Kidwell and Rogowski, 1983). Furthermore, Butler (2008) argues that in many cases municipal bonds only attract interest from local investors. Thus, distance is a significant driver in the outcome of municipal bond underwriting and small municipalities may have difficulties in obtaining funding from institutions that provide access to capital markets.

Because of the heterogeneous nature of various municipalities (for example, in terms of size and credit rating), MBBs offer different benefits to their participants and some municipalities benefit more than others from bond bank participation. While a large bond issuer can generate savings in the market from open tender, there is a niche for the credit-pooling financing agent to fulfil for smaller and less experienced municipalities. Many individual municipality bond issues are small, which leads to relatively high transaction costs, such as legal, distribution, printing, advertising and bond underwriting costs. Bond underwriters charge direct fees and generate gains (a cost to investors and issuers) from reselling these bonds to investors. On the other hand, the municipal bond bank offers economies of scale, bond issuing expertise and relatively strong balance sheets, bolstered by reserve funds. This is attractive to a municipality that may lack the financial knowledge, size or credit rating to issue bonds on an irregular basis.

However, a large municipality may command a higher credit rating than that of an MBB. Seeing little benefit from joining the bond issuance of a municipal bond bank, it may choose to issue its own debt. It might have concerns about implicitly reducing its own debt capacity and believe that debt issued in its own name is sufficiently liquid, will improve investor name recognition and assist in developing its own credit history. Furthermore, joining the bond issuance programmes of an MBB means a relative lack of flexibility in timing. Most MBBs issue series of bonds two-to-four times per year and the issue process is time consuming, as the MBB invites participations and screens applications. By contrast, individual municipalities are able to issue at a time of their choosing in normal market conditions, notwithstanding the transaction costs and their relative credit ratings.

The paper is divided as follows: Section 2 summarises relevant literature. Section 3 defines the probit regression model, including collection of yield spread data and important variables. Section 4 presents descriptive statistics, a linear regression of the municipality's MBB participation choice and a propensity score matching method to measure treatment effects. Section 5 contains concluding remarks.

LITERATURE REVIEW

Much of the literature that covers the control regressors in this chapter is discussed on pages 43-47 in Chapter 1 and is not repeated here, where the focus is rather on literature that is directly related to North American municipal bond banks.

Most US MBBs benefit from the implicit guarantee or moral obligation of their respective State. Hsueh and Kidwell (1988) look at the effect of a State bond guarantee via the Texas Permanent School Fund bond guarantee programme, which is a stronger condition than the moral obligation of the State to MBBs' programmes. School districts achieved interest cost savings between 40-98 basis points for single A to Baa rated issuers respectively, due to the bond guarantee programme, although AA-rated issuers enjoyed no interest cost savings and AAA-rated issuers paid a yield of 18 basis points above that of non-school AAA-rated issuers.

Gilbert and Pike (1998) study Canadian subnational government debt, where municipal finance agency (MFA) loans are directly guaranteed by provincial governments. Their sample of 122 responses within Ontario shows that pooled financing through an MFA generates cost savings in aggregate, resulting from reduced costs of capital and lower administration costs. Using the hypothetical MBB yield curve approach, also adopted in this thesis, they conclude that an MFA generates interest cost savings for municipalities in inverse proportion to credit rating and population - small municipalities benefit more than large municipalities.

Cole and Millar (1982) find a cross-subsidisation effect: MBBs generate cost savings for small, higher-risk issuers and the magnitudes of these cost savings increase with the State bond bank's reputation. On the other hand, larger, higher-credit-quality issuers face higher costs if they market their bonds through a bond bank than if they take them directly to market. They establish that issuers' interest costs are influenced by characteristics, such as bond issue size, credit rating and issue type. Interest savings arise from MBB participation in Maine on a sample of 282 bond issues, but municipalities with credit ratings above A and large issue size should investigate other borrowing methods.

Kidwell and Rogowski (1983) investigate savings from participation in bond banks, focusing upon 651 long-term serial bond issues in Maine and Vermont. They conclude that small, low-rated municipalities derive the greatest benefit from participation in MBB issues. Benefits range up to 154 basis points. Municipalities with a credit rating of Aaa, issuing more than US$5 million, derive no benefit from MBB participation. They also identify bond issue size and sale-type (negotiated or competitive underwriting arrangement) as significant regressors of interest costs.

Reid (1990) claims that the bond bank benefits from increased issue size (lower underwriting costs and greater bond marketability) and reduction of risk to investors. However, municipal bond banks offer no benefit to large, well-known individual municipality bond issuers. He estimates that negotiated underwriting offerings sell at a premium to competitive underwriting offerings. Simonsen et al. (2001) study issue size and sale type with data from municipal bond issues in Oregon, where there is no MBB. They conclude that smaller municipalities pay a higher yield-to-maturity and competitive underwritten sales generate lower yields than negotiated underwritten sales.

Katzman (1980) investigates the log-odds of participation in a bond bank through a logit regression and concludes that individual municipalities benefit from the credit rating and bond issue size of the MBB across a pooled sample of 162 bond issues. Looking at new bond issue re-offer yields, he compares the costs to municipalities that participate in the Maine and Vermont Municipal Bond Banks with those they would have incurred, had they issued independently, and finds that interest cost savings accrue only for those municipalities rated at least one grade below the MBB's rating. These savings increase as the prospective participant's rating decreases compared to the MBB's rating.

PROBIT REGRESSIONS ON PARTICIPATION IN MBB BOND ISSUES

I begin my analysis by identifying whether an individual municipality's credit rating and the size of its funding requirement are significant regressors of the decision to participate in an MBB bond issue. Following the lead of Katzman (1980), I estimate a probit regression of participation in an MBB bond series issue over 2012-16, by regressing on the credit rating and participation size of an individual municipality, firstly across the full sample of five States, with the longest-standing MBBs, and then by individual State.

The regression takes the form:

$$Prob\,(BOND_{it} = 1) = \alpha + X_{it}\,\beta + Z_{it}\,\gamma + \epsilon_{it}\ ;\ \epsilon_{it} \sim IID\,(0, \sigma_{\epsilon}^2)$$

$BOND_{it}$, is a dummy variable that equals 1 if municipality i participates in an MBB bond issue and equals zero otherwise at time t.

X_{it} represents the credit rating of the municipality.

Z_{it} represents the required participation size of the municipality.

Regression data

Early studies in the literature collected data by survey. My samples are larger and the participants in a MBB bond issue can be identified by both credit rating and size of participation in the pooled bond issue. As an example, the Maine Municipal Bond Bank represented 29 municipalities and governmental units with a series of ten bond issues of maturities between one and ten years on 25th October 2012. The Maine Municipal Bond Bank is rated by Moody's at Aa2, while 24 participating municipalities are not rated and the other five are rated at Aa1, Aa2, A1, A2 and Baa1 respectively.

If a municipality or MBB wishes to issue bonds, it will decide upon a series of issues of different terms. All individual bond issues are grouped into their respective series. In my sample, the 5,726 individual municipality bonds can be grouped as 654 bond series. By contrast, the 893 MBB bond issues represent 65 bond series. Different municipalities made 447 decisions to participate in an MBB's bond series.

Therefore, I am comparing 654 + 447 = 1,101 decisions of individual municipalities to participate in bond series. The credit rating of each participating municipality in an MBB bond issue can be identified from the Moody's database, together with the amount of the bond issue which is attributable to each municipality (either individually or within the MBB programme) from MSRB data.

Of the municipalities that participated in an MBB bond series issue, 81.2% held no credit rating from Moody's. This does not necessarily mean that they are of poor credit quality. They may decide that they do not need to acquire a credit rating, if they are to participate in an MBB bond series issue.

In general, individual municipality bonds are issued by higher-rated municipalities: 68.4% of the bond series issued by individual municipalities carried a Moody's rating of Aa3 or higher. However, at the other extreme, some non-rated municipalities did issue their own bonds: 4.5% of individual municipality bonds are issued by non-rated municipalities.

Throughout the analysis, I assume that a municipality pre-determines a set demand of funding before it decides to issue its own bond or apply to participate in an MBB bond issuance. Municipalities with a smaller demand for bonds use MBBs: on the 447 occasions that municipalities participated in an MBB bond series issue, 70.6% required less than US$2m, 17.4% required between US$2m and US$5m, and just 12.0% of bond participants in MBBs required in excess of US$5m. On the other hand, of the 654 bond series that were issued by individual municipalities only 26.4% were less than US$2m, 22.5% were between US$2m and US$5m, and 51.1% more than US$5m.

Regression results

Table 24 presents probit regressions across five States. While the results confirm the conclusions of the literature, interpretation requires some care. For example, 'Not Rated' is a significant and positive regressor. A participant in an MBB bond series may determine that a credit rating is not necessary, regardless of their credit quality. Thus, there may not be a clear causal relationship between MBB bond issue participation and the credit quality of a municipality. Nonetheless, the regressors of participating in an MBB bond series issue are negative and significant for all credit ratings of Baa1 and above in Model 1 below. Among the categorical variables, I exclude the low credit-rated category of Ba1.

Table 24: Probit Regressions of MBB Bond Issues — Credit Rating & Participation Size

Estimator	Credit ratings (1)	Size of participation (2)	Mixed (3)
Aa1	-1.691 ***		-1.303 ***
	(0.208)		(0.238)
Aa2	-0.872 ***		-0.439 **
	(0.104)		(0.156)
Aa3	-1.288 ***		-0.918 ***
	(0.124)		(0.168)
A1	-1.239 ***		-0.832 ***
	(0.208)		(0.238)
A2	-0.748 ***		-0.348
	(0.209)		(0.243)
Baa1	-1.111 ***		-0.774 *
	(0.408)		(0.440)
Baa2	0.180		0.723
	(0.477)		(0.482)
Not Rated	0.949 ***		1.259 ***
	(0.071)		(0.154)
Size < \$1m		0.450 ***	-0.178
		(0.077)	(0.162)
\$1m < Size <\$2m		0.164 *	-0.159
		(0.089)	(0.162)
\$2m < Size <\$5m		-0.394 ***	-0.440 ***
		(0.086)	(0.163)
\$5m < Size <\$10m		-0.790 ***	-0.739 ***
		(0.121)	(0.191)
\$10m < Size <\$20m		-1.360 ***	-1.254 ***
		(0.152)	(0.226)
Number of observations	1,101	1,101	1,101
Dependent variable = 0	654	654	654
Dependent variable = 1	447	447	447
Log likelihood	-459.3	-665.8	-433.3

Source: Calculated; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; constant term suppressed; if the dependent variable = 1, the bond is an MBB bond, if the dependent variable = 0, the bond is not an MBB bond; credit ratings AAA and A3 are excluded, as they perfectly predict binary response failure; credit rating Ba1 excluded; size > \$20m excluded

In Model 2, municipalities with bond issue requirements of less than USS\$2m have positive and significant regressors, while the regressors of those with larger requirements are all negative and significant. These results suggest that municipalities with high credit ratings and larger funding requirements are less likely to participate in MBB bond issues. Among the categorical variables, I exclude the largest category of participation size, which is over US\$20m.

I also run the regressions with State fixed effects (not reported). These do not change the signs of the regressors, although in a number of cases, their significance is reduced. For example, the regressors of A1, A2 and Baa1 lose significance in Model 1 with State fixed effects and the US\$5-10m size regressor loses significance in Model 2 with State fixed effects. Some 245 individual municipalities issue bonds in addition to the five MBBs. I do not report municipality fixed effects.

Tables 25 and 26 show the marginal effects of the probit regressions. The former indicates that as the credit rating of the individual municipality improves above Baa2, it is less likely to use the services of an MBB. The latter shows that as the size of the individual municipality's participation requirement decreases below US$2m, it is more likely to use the services of an MBB.

Table 25: Marginal Effects of Probit Regressions — Credit Rating

Estimator	Marginal effect
Aa1	-0.390 *** (0.046)
Aa2	-0.201 *** (0.022)
Aa3	-0.297 *** (0.025)
A1	-0.286 *** (0.046)
A2	-0.173 *** (0.048)
Baa1	-0.256 *** (0.093)
Baa2	0.042 (0.090)
Not Rated	0.219 *** (0.013)

Source: Calculated; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 26: Marginal Effects of Probit Regressions — Size of Bond Participation

Estimator	Marginal effect
Size < $1m	0.146 *** (0.024)
$1m < Size <$2m	0.053 * (0.029)
$2m < Size <$5m	-0.128 *** (0.027)
$5m < Size <$10m	-0.256 *** (0.037)
$10m < Size <$20m	-0.441 *** (0.045)
Size > $20m	-0.294 *** (0.042)

Source: Calculated; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

I repeat the probit models with month fixed effects included, which allows for seasonal factors. Results are similar to those of Table 24, albeit with reduction or loss of significance in a number of regressors.

Table 27: Probit Regressions of MBB Bond Issues with Month Fixed Effects

Estimator	Credit ratings (1)	Size of participation (2)	Mixed (3)
Aa1	-0.941 ***		-0.704 **
	(0.279)		(0.300)
Aa2	-0.223		0.034
	(0.219)		(0.242)
Aa3	-0.587 **		-0.380
	(0.233)		(0.253)
A1	-0.578 *		-0.343
	(0.299)		(0.315)
A2	0.011		0.197
	(0.296)		(0.314)
Baa1	-0.201		-0.042
	(0.410)		(0.486)
Baa2	0.817		1.182 **
	(0.548)		(0.539)
Not Rated	1.642 ***		1.795 ***
	(0.210)		(0.241)
Size < $1m		0.893 ***	-0.186
		(0.145)	(0.183)
$1m < Size <$2m		0.638 ***	-0.062
		(0.152)	(0.186)
$2m < Size <$5m		0.075	-0.350 *
		(0.150)	(0.183)
$5m < Size <$10m		-0.290	-0.624 ***
		(0.179)	(0.217)
$10m < Size <$20m		-0.882 ***	-1.204 ***
		(0.198)	(0.247)
Number of observations	1,101	1,101	1,101
Dependent variable = 0	654	654	654
Dependent variable = 1	447	447	447
Log likelihood	-393.1	-552.0	-373.6

Source: Calculated; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; constant term suppressed; if the dependent variable = 1, the bond is an MBB bond, if the dependent variable = 0, the bond is not an MBB bond; credit ratings AAA and A3 are excluded, as they perfectly predict binary response failure; lowest rated, Ba1 is excluded; size > $20m excluded

I include linear regression models in Table 28. Most regressors are significant. The lower and non-rated credit rating and the smallest size of participation estimators command the largest positive regression coefficients. These are relative to the omitted categories of credit rating Ba1 and participation size > US$20m respectively.

Table 28: Linear Regressions of MBB Bond Issues - Credit Rating & Participation Size

Estimator	Credit ratings (1)	Size of participation (2)	Mixed (3)
constant	0.001	0.183 ***	-0.009
	(0.309)	(0.036)	(0.300)
Aa1	0.045		-0.087 ***
	(0.033)		(0.025)
Aa2	0.192 ***		0.212 ***
	(0.025)		(0.031)
Aa3	0.099 ***		0.103 ***
	(0.025)		(0.0251)
A1	0.108 **		0.123 ***
	(0.043)		(0.040)
A2	0.227 ***		0.227 ***
	(0.052)		(0.065)
Baa1	0.133		0.146 *
	(0.090)		(0.086)
Baa2	0.571 ***		0.588 ***
	(0.131)		(0.195)
Not Rated	0.829 ***		0.784 ***
	(0.017)		(0.025)
Size < $1m		0.491 ***	0.082 *
		(0.046)	(0.043)
$1m < Size <$2m		0.382 ***	0.091 **
		(0.050)	(0.043)
$2m < Size <$5m		0.164 ***	0.006
		(0.048)	(0.037)
$5m < Size <$10m		0.032	-0.053
		(0.051)	(0.039)
$10m < Size <$20m		-0.096 **	-0.123 ***
		(0.043)	(0.037)
Number of observations	1,101	1,101	1,101
Dependent variable = 0	654	654	654
Dependent variable = 1	447	447	447
R-squared	0.505	0.193	0.523

Source: Calculated; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
if the dependent variable = 1, the bond is an MBB bond, if the dependent variable = 0, the bond is not an MBB bond; credit ratings AAA and A3 are excluded, as they perfectly predict binary response failure;
lowest rated, Ba1 is excluded; size > $20m excluded

State-by-State results

Table 29 details regressions on credit ratings by individual State. The omitted variable is Ba1 in Maine, North Dakota and Vermont or Baa2 in Alaska and New Hampshire. Every significant credit rating regressor of A1 or higher records a negative regressor, while Not Rated is a significant and positive regressor in three States. Higher rated municipalities tend not to use the services of an MBB anywhere, while non-rated municipalities tend to use the MBB in Alaska, Maine and Vermont.

Table 29: Probit Regressions of MBB Bond Issues on Credit Rating by State

Estimator	Alaska	Maine	New Hampshire	North Dakota	Vermont
Aa1	-	-1.478 ***	-	-1.550 ***	-
	-	(0.290)	-	(0.346)	-
Aa2	-0.736 ***	-0.197	-1.680 ***	-1.991 ***	-1.565 ***
	(0.272)	(0.158)	(0.330)	(0.418)	(0.487)
Aa3	0.097	-1.282 ***	-1.068 ***	-	-0.842 *
	(0.348)	(0.221)	(0.293)	-	(0.452)
A1	-	-1.465 ***	-0.349	-1.565 ***	-
	-	(0.505)	(0.386)	(0.344)	-
A2	-	0.319	0.140	-	-
	-	(0.451)	(0.419)	-	-
Baa1	-	-0.431	-	-	-
	-	(0.749)	-	-	-
Baa2	-	-	-	0.431	0.431
	-	-	-	(0.749)	(0.749)
Not Rated	1.550 ***	1.601 ***	-	-0.798 ***	1.956 ***
	(0.346)	(0.181)	-	(0.158)	(0.244)
Number of observations	98	330	198	313	162
Dependent variable = 0	53	166	105	289	41
Dependent variable = 1	45	164	93	24	121
Log likelihood	-48.6	-118.8	107.1	-33.7	-33.7

Source: Calculated; key: robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; where a regressor is not quantified, it is because it is a perfect predictor of Mutual = 1 or 0; constant term suppressed; lowest rated, Ba1 is excluded in Maine, North Dakota and Vermont or Baa2 otherwise

Table 30 summarises regressions on participation size by State. The omitted variable is 'size > US$20m'. All significant regressors of size of participation of less than US$2m, except in North Dakota, are positive and all significant regressors of size of participation in excess of US$5m are negative. Municipalities with smaller funding requirements tend to use the services of an MBB, while those with larger funding requirements tend not to.

Table 30: Probit Regressions of MBB Bond Issues on Size of Participation by State

Estimator	Alaska	Maine	New Hampshire	North Dakota	Vermont
Size < \$1m	-	1.388 ***	-	-1.495 ***	1.856 ***
	-	(0.173)	-	(0.204)	(0.310)
\$1m < Size <\$2m	1.335 **	0.506 ***	0.785 ***	-1.106 ***	1.712 ***
	(0.530)	(0.167)	(0.231)	(0.193)	(0.461)
\$2m < Size <\$5m	0.674 *	-0.784 ***	0.366 *	-1.763 ***	0.722 ***
	(0.393)	(0.181)	(0.198)	(0.261)	(0.237)
\$5m < Size <\$10m	0.000	-1.322 ***	-0.566 **	-1.565 ***	0.000
	(0.335)	(0.266)	(0.251)	(0.344)	(0.313)
\$10m < Size <\$20m	-0.589 *	-1.803 ***	-1.668 ***	-0.502	-0.722 **
	(0.315)	(0.446)	(0.331)	(0.364)	(0.335)
Number of observations	98	330	198	313	162
Dependent variable = 0	53	166	105	289	41
Dependent variable = 1	45	164	93	24	121
Log likelihood	-57.1	-127.8	-93.6	-99.6	-58.1

Source: Calculated; key: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; where a regressor is not quantified, it is because it is a perfect predictor of Mutual = 1 or 0; size > \$20m excluded

THE BENEFIT OF MBB PARTICIPATION

With regard to the second research question, the aim is to identify the interest cost advantage that a US credit-pooling agency offers to a participant in its bond issues. Following the approach of Gilbert and Pike (1998), the effect of participation in an MBB bond issue is estimated on a bond's yield spread, relative to a duration-matched point on a hypothetical MBB bond yield curve. It is possible to identify whether bond issues are those of individual municipalities or of MBBs. Using an MBB participation dummy and control variables, I undertake linear regressions.

The yield-to-maturity of an individual municipal bond or MBB bond is directly observable. To create the spread, I estimate a zero-coupon hypothetical MBB yield curve within each State for fixed coupon, fixed maturity bonds. The median duration of all municipal bonds in my sample is 4.66 years, so I identify the closest live MBB bond to a five-year maturity as the reference bond for a particular State at a given time. Using Bloomberg secondary market data, I also identify the 15 closest 'observed comparables' municipal bonds of different terms and coupons to this reference bond. Bloomberg identifies these as part of its proprietorial curve building methodology, as recently traded and sufficiently liquid securities that most closely compare to a given reference bond. Armed with the relevant secondary market data for these bonds, I use the Nelson-Siegel-Svensson curve-building methodology to generate zero-coupon MBB benchmark yield curves for each State (this is defined in the Appendix to Chapter 1).

There is a risk that selection bias may affect the results, because the difference in the average outcome between participating in an MBB bond issue and issuing a bond individually may be caused by confounding variables that predict participation rather than the participation itself. Thus, propensity score matching is also used to estimate the effect of participation in an MBB bond issue, which is then compared to the linear regression results. This method accounts for the covariates that predict participation, and it reduces bias, due to confounding variables that could be found in a simple OLS estimate of the impact of MBB bond issue participation on yield spreads. Propensity scores are predicted probabilities that are used to find close non-treated matches for the treated observations. The methodology assigns observations into two groups:

- a treated group (MBB bond participation)
- a control group (individual bond issues).

It estimates a probit model for the propensity of observations to be assigned into the treated group. A propensity score is generated that is the conditional probability of receiving the treatment, given the pre-treatment characteristics of the bond/issuer. This allows me to refine the sample used to estimate average treatment effects. I can thus draw inference for treatment effects from a smaller group of treated and non-treated observations (MBB bond participation and individual bond issuers) of similar propensity scores, rather than from the full set of observations.

My sample is based on observation of every municipal bond issued in five States over the period 2012-16. I first run OLS regressions on the full sample and then study refined propensity score matching samples for treatment effects that use techniques, such as nearest neighbour matching or kernel matching.

I construct the dependent variable, Y_{ijt}, as the yield spread at primary issue of the individual municipality or MBB bond, relative to the duration-matched hypothetical MBB bond yield for its respective State of issuer. It varies from issuer to issuer (i), bond to bond (j) and over time (t).

I estimate the zero-coupon hypothetical MBB yield curve for fixed coupon, fixed maturity MBB bonds, based on secondary market data (see Methodology on page 100 for definition).

I estimate Y_{ijt} by linear regression for the bond issues within each State in a model:

$$Y_{ijt} = \alpha + X_{ijt}\,\beta + Z_{ijt}\,\gamma + \epsilon_{ijt}\ ;\ \epsilon_{ijt} \sim IID\,(0,\, \sigma_{\epsilon}^{2})$$

The main regressor of interest is X_{ijt}, which is a dummy for participation in an MBB bond issue.

Z_{ijt} is a vector of control variables that include bond duration, liquidity, coupon, a competitive underwriting dummy, bond tax status dummies and credit rating dummies.

Issue size, price and yield-to-maturity data are sourced from Bloomberg. The MSRB provides data for municipal bond banks, such as individual municipality participants, bond underwriting and tax status, which earlier papers had to access by survey. Credit ratings are sourced from Moody's. These data are all directly observable.

Other regressors

Liquidity

Katzman (1980), Kidwell and Rogowski (1983) and Reid (1990) use the logarithm of the value of the bond issued in USD millions as an instrument for liquidity at the time of primary issue. For ease of economic interpretation, I use the value of the bond issued in USD millions, which can be calculated from MSRB data.

Coupon

As in Chapter 1, I show that bond coupon is often a significant regressor of yield spread. This may relate to tax considerations: Schaefer (1982) finds a relationship between different UK gilts' tax clienteles through the percentage of a bond's total return in the form of coupon income relative to capital gain. Kim et al. (1993) show that a default risk in bond coupons affects valuation. Elton et al. (2001) argue that because coupon is higher for lower-rated debt, then its tax burden is higher, suggesting a tax effect.

Bond issue underwriting methods

I investigate which method of bond underwriting generates lower interest costs for an issuer. Kidwell and Rogowski (1983), Reid (1990) and Simonsen et al. (2001) include analyses of the effect of different types of underwriting on the interest costs of bond issuance. Two methods of bond underwriting – competitive and negotiated – are used in approximately equal measure across my full sample:

A competitive sale is a method in which underwriters submit bids for the purchase of a new issue of municipal bonds on a given date, either alone or as a syndicate. The securities are awarded to the underwriting syndicate that presents the bid that represents the lowest interest cost to the seller. Buyers will have applications filled on a first-come, first-served basis during the order period.

In a negotiated sale municipal bonds are issued under an exclusive agreement with an underwriter or syndicate that is selected by the issuer. This method tends to occur in larger, more complex issues. Depending upon the rate of book-building (flow of orders), the underwriter can recommend to increase or reduce the interest rates on the new bonds to optimise the issuer's net receipts.

Tax structure of municipal bonds and tax dummies

Investing in US municipal bonds is often tax efficient relative to other US bond markets for a tax-bearing investor. Literature on the impact of the tax exemption on municipal bonds pricing includes Dammon and Green (1987), who find evidence of the tax advantage in the US municipal bond yield curve; Wang et al. (2006) control for the effects of default and liquidity risk and obtain implicit tax rates that are close to the statutory tax rates of high-income individuals and corporations; Ang et al. (2014) claim that the tax exemption component of municipal bonds has lowered yields by 1.84% since 2008.

I investigate the effect of different tax categories on yield spreads. Federal and State tax exempt or Federal bank qualified and State tax-exempt bonds represent over 85% of the sample. Taxable municipal bonds also exist. There is one bond in the sample, identified as 'Federal taxable', which serves as the excluded bond in the linear regressions. Eight other categories of Federal tax and State tax status are identified across the regression sample, as follows:

Tax 1 – Federal and State tax exempt (57.62% of the sample)

Tax 2 – Federal bank qualified/State tax exempt (27.63% of the sample)

Tax 3 – Federal tax exempt (3.91% of the sample)

Tax 4 – Federal bank qualified (0.20% of the sample)

Tax 5 – Federal tax exempt/State taxable (0.12% of the sample)

Tax 6 – Federal alternative minimum tax/State tax exempt (4.79% of the sample)

Tax 7 – Federal taxable/State tax exempt (4.76% of the sample)

Tax 8 – Federal taxable/State taxable (0.95% of the sample)

State tax-exempt bonds include municipal issues that are exempt from State and often local taxes. In this case, investors who reside in the State of issuance are not taxed on their interest earnings at the State level. Thus, the effective yield they earn on the bond will actually be higher than the stated yield.

Bank qualified describes a class of municipal securities that enjoy a tax-advantaged status when purchased by commercial banks. Prior to the 1986 Tax Reform Act, commercial banks could take investment tax credits on funds invested in tax-exempt securities. The 1986 Act removed this benefit, except for securities designated as 'bank qualified'. Thus, demand by commercial banks for tax-exempt securities is almost entirely limited to bank-qualified issues. In order to meet the requirements for 'bank qualification,' municipal bonds must pass certain 'public activity' tests.

Alternative minimum tax is a supplemental income tax, imposed by the US Federal government in addition to baseline income tax for individuals, corporations, estates and trusts that have exemptions allowing for lower payments of standard income tax. Taxpayers with incomes above the exemption, whose regular Federal income tax is below a given amount, must pay the higher AMT amount.

Taxable municipal bonds exist because the Federal or State government will not subsidise the financing of certain activities that it does not deem to provide a significant benefit to the public. Investor-led housing, local sports facilities and refunding of an existing issue are examples of bond issues that are federally taxable.

Linear regression data

The sample for the linear regressions includes bonds issued by 250 entities, drawn from five States, including five Municipal Bond Banks. 6,619 fixed-coupon, fixed maturity-date bonds were issued across Alaska, Maine, New Hampshire, North Dakota and Vermont – the States with the longest standing MBBs –from January 2012 to December 2016. They represent every municipal bond issued in these States over the period. On average, MBB bonds are longer dated than municipal bonds, although their yield-to-maturity is lower.

Table 31: Summary Data of Municipal and MBB Bonds

Moody's Credit Rating	MBBs	Individual Municipalities
Average duration	4.90 years	4.62 years
Average yield-to-maturity	1.454%	1.495%
Average yield spread to MBB curve	10.7 basis points	13.1 basis points

Source: Calculated

Bond issue size

The average size of the bond issues of individual municipalities of US$1.253m compares with US$1.923m for the average of each bond issued by an MBB. An issuer may issue up to 20 bonds in a series of different terms at one time.

Table 32: Issue Size of Municipal Bonds

Issue Size	Number of Bonds Issued By MBBs	Number of Bonds Issued By Municipalities
< $1 million	323 (36.2%)	3,936 (68.8%)
$1-2 million	259 (29.0%)	945 (16.5%)
$2-3 million	147 (16.4%)	500 (8.7%)
> $3 million	164 (18.4%)	345 (6.0%)
Total	893	5,726

Source: MSRB

Credit ratings

The average credit rating of an MBB bond is higher than that of an individual municipality bond. 232 bonds were issued with an Aaa credit rating, as determined by Moody's. These include the North Dakota Public Finance Authority, the Maine Municipal Bond Bank and six individual municipalities. At the other extreme, 259 individual municipal bonds were unrated by the major credit ratings agencies. Many municipalities do not seek credit ratings, given maintenance costs and the infrequency of their need for funds.

Table 33: Ratings of Municipal and MBB Bonds

Moody's Credit Rating	Number of Bonds Issued by	Number of Bonds Issued by
Aaa	117 (13.1%)	115 (2.0%)
Aa1	-	1,210 (21.1%)
Aa2	636 (71.2%)	1,443 (25.2%)
Aa3	120 (13.4%)	1,534 (26.8%)
A1	-	500 (8.8%)
A2	20 (2.3%)	261 (4.6%)
A3	-	219 (3.8%)
Baa1	-	144 (2.5%)
Baa2	-	30 (0.5%)
Ba1	-	10 (0.2%)
Ba2	-	1 (-)
Unrated	-	259 (4.5%)
Total	893	5,726

Source: MSRB

Linear regression results

OLS regressions of the yield spread relative to the hypothetical MBB yield curve for a sample of all bonds issued across the five States over 2012-16 are summarised in Table 34. They suggest that participating in the bond issuance programme of an MBB generates interest cost savings for a municipality. Issuing bonds through a Municipal Bond Bank saves between 6.2 and 8.1 basis points of yield spread relative to individual bond issuance, depending upon fixed effects.

Controlling for State fixed effects makes little difference to the R-squared of the results, but the absolute size of the Municipal Bond Bank regressor is larger, at -7.9 basis points, than in the base model. Adding time fixed effects implies an MBB dummy coefficient of -6.9 basis points. The Wald test implies that the time fixed effects model is appropriate ahead of OLS Model 1.

Most other regressors are significant. Yield spreads rise by between 1.1 and 1.4 basis points per year of duration. They fall by between 0.3 and 0.4 basis points per US$m increase in issue size in models without time fixed effects. In economic terms, the liquidity regressors are small numbers, considering the average size of bond issue. Indeed, this regressor loses significance when time effects are added to the base model. Yield spread rises by between 3.7 and 4.4 basis points per 100 basis point change in coupon. Competitive underwriting agreements save issuers between 24.5 and 27.3 basis points relative to negotiated underwriting agreements. This is an interesting result, given that negotiated underwriting tends to happen on more complex issues.

All tax category regressors are significant. Tax categories 1, 2 3, 4 and 5 have the most favourable status at the Federal level and these significant regressors are the most negative relative to the omitted category, which is Federal taxable. Credit rating regressors are significant in all models, with the exception of Baa2. In general, higher credit-rated bond regressors are more negative relative to Ba2, the omitted category, than lower credit-rated bonds.

I interact duration and liquidity with the State regressors and check for significance within the resulting regressions. Interacting duration with State in Model 1, the Alaska and North Dakota regressors lose significance. Interacting liquidity with State, the regressors for Alaska, New Hampshire and North Dakota lose significance. These results are not reported in the chapter.

Table 34: Regression of Yield Spread for Full Sample

Estimator	OLS (1)	OLS (2)	OLS (3)	OLS (4)
Constant	2.504 ***	2.465 ***	2.299 ***	2.231 ***
	(0.062)	(0.066)	(0.082)	(0.085)
Municipal Bond Bank	-0.062 ***	-0.079 ***	-0.069 **	-0.081 ***
	(0.012)	(0.012)	(0.012)	(0.031)
Duration	0.014 ***	0.012 ***	0.012 ***	0.011 ***
	(0.002)	(0.002)	(0.002)	(0.002)
Liquidity ($mn)	-0.004 **	-0.003 **	-0.004	-0.003
	(0.002)	(0.001)	(0.002)	(0.002)
Coupon	0.037 ***	0.040 ***	0.042 ***	0.044 ***
	(0.004)	(0.004)	(0.004)	(0.004)
Competitive u/w	-0.273 ***	-0.265 ***	-0.255 ***	-0.245 ***
	(0.009)	(0.010)	(0.009)	(0.010)
Tax 1	-1.756 ***	-1.796 ***	-1.853 ***	-1.864 ***
	(0.013)	(0.016)	(0.034)	(0.035)
Tax 2	-1.882 ***	-1.912 ***	-1.966 ***	-1.968 ***
	(0.017)	(0.019)	(0.034)	(0.036)
Tax 3	-1.214 ***	-1.284 ***	-1.366 ***	-1.395 ***
	(0.028)	(0.028)	(0.040)	(0.040)
Tax 4	-1.917 ***	-1.883 ***	-2.024 ***	-1.975 ***
	(0.020)	(0.025)	(0.037)	(0.041)
Tax 5	-1.108 ***	-1.159 ***	-1.216 ***	-1.232 ***
	(0.027)	(0.029)	(0.041)	(0.042)
Tax 6	-1.704 ***	-1.612 ***	-1.746 ***	-1.645 ***
	(0.060)	(0.069)	(0.064)	(0.070)
Tax 7	-1.968 ***	-2.007 ***	-1.915 ***	-1.963 ***
	(0.041)	(0.042)	(0.056)	(0.056)
Tax 8	-1.270 ***	-1.317 ***	-1.323 ***	-1.345 ***
	(0.055)	(0.058)	(0.052)	(0.053)
Aaa	-0.722 ***	-0.708 ***	-0.819 ***	-0.808 ***
	(0.061)	(0.062)	(0.066)	(0.067)
Aa1	-0.750 ***	-0.746 ***	-0.871 ***	-0.867 ***
	(0.058)	(0.059)	(0.063)	(0.063)
Aa2	-0.774 ***	-0.792 ***	-0.844 ***	-0.856 ***
	(0.058)	(0.059)	(0.063)	(0.063)
Aa3	-0.705 ***	-0.723 ***	-0.808 ***	-0.821 ***
	(0.058)	(0.059)	(0.062)	(0.063)
A1	-0.556 ***	-0.567 ***	-0.688 ***	-0.691 ***
	(0.058)	(0.059)	(0.063)	(0.064)
A2	-0.466 ***	-0.488 ***	-0.573 ***	-0.588 ***
	(0.061)	(0.062)	(0.064)	(0.065)
A3	-0.282 ***	-0.363 ***	-0.375 ***	-0.440 ***
	(0.066)	(0.067)	(0.069)	(0.069)
Baa1	-0.289 ***	-0.339 ***	-0.339 ***	-0.380 ***
	(0.083)	(0.067)	(0.071)	(0.072)
Baa2	-0.126	-0.165 **	-0.271 ***	-0.294 ***
	(0.084)	(0.077)	(0.089)	(0.081)
No credit rating	-0.327 ***	-0.345 ***	-0.413 ***	0.429 ***
	(0.071)	(0.072)	(0.073)	(0.073)
State fixed effects	No	Yes	No	Yes
Time fixed effects	No	No	Yes	Yes
Number of observations	6,619	6,619	6,619	6,619
R-squared	0.508	0.525	0.612	0.625

Source: Calculated; key: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
one observation of Ba2 credit rating omitted; one observation of Federal Taxable (the least favourable tax category) omitted; negotiated underwriting dummy omitted

Cluster robust errors

Following Cameron and Miller (2015), I also undertake the main regression analysis, including cluster robust standard errors, clustering about the States by month of bond issue (not reported). This creates 225 clusters. These errors are greater than heteroscedasticity-adjusted errors and the Mutual dummy loses significance in the base model without fixed effects. In the other models it is significant at the 5% level. The significance of duration falls to the 5% level in the models with State fixed effects and both time and State fixed effects. The significance of issue size falls to 10% in the base model and the model with State fixed effects. All other regressors, except Baa2, remain significant at the 1% level.

Liquidity and credit rating regressors

The liquidity and credit rating ('Aaa' to 'No credit rating') regressors within Table 34 are different from those in the regressions of Tables 24 to 30, but there is an overlap. For example, each of the credit ratings of the 1,101 bond series observations in Table 24 are those of the individual municipality (which decides whether or not to participate in an MBB bond series). On the other hand, each of the 6,619 observations of credit ratings in Table 34 represents the individual bond issued. Of these, 893 are MBB bonds and therefore not those of the individual participating municipality. Only 259 of the 6,619 municipal bonds were unrated by the major credit rating agencies, whereas 81.2% of the municipalities that participated in an MBB bond series issue held no credit rating from Moody's.

Similarly, for liquidity from Tables 24 to 30, I look at either the size of participation in an individual municipality's bond series or of its participation within MBB bond series, whereas in Table 34 liquidity reflects the size of the actual bond issued.

Characteristics of the residuals

None of the credit rating controls correlate with the residuals of any of the models within Table 34, which does not suggest bias. However, I have also undertaken linear regressions that exclude all credit ratings regressors (not reported). The Mutual regressor is much larger in all revised models. For example, it rises to a highly significant -0.16 in Model 1, -0.17 in Model 2, -0.15 in Model 3 and -0.15 in Model 4. These are also much larger figures than the treatment effects of the propensity score matching results, which are presented below.

The correlations of the residuals of regression Model 4 in Table 34 against all regressors of interest are each zero. A check for collinearity between regressors is presented in Table 35. There is some correlation between contemporaneous regressors, in particular coupon and other regressors:

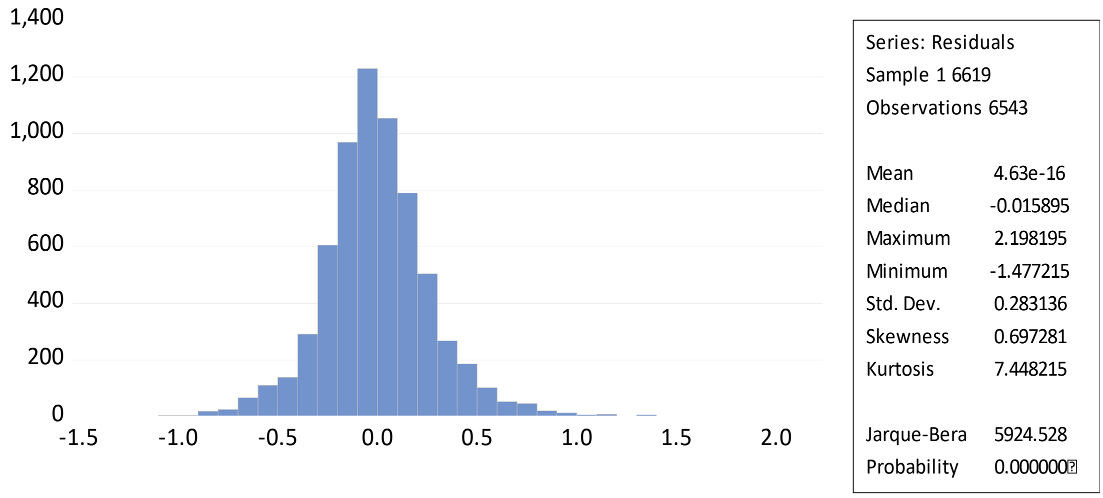
Table 35: Pair-wise Correlations of the Contemporaneous Variables

Correlation	Yield Spread	Mutual	Competitive	Duration	Liquidity	Coupon
Yield Spread	1	-0.014	-0.457	0.101	0.137	0.154
Mutual		1	-0.163	0.041	0.238	0.195
Competitive			1	-0.045	-0.332	-0.147
Duration				1	0.093	0.332
Liquidity					1	0.424
Coupon						1

Source: Calculated; liquidity is represented by the log of the issue size

An issuer might issue a series of up to 20 bonds of different terms on the same day. A Breusch-Pagan test rejects constant variance of the residuals, suggesting heteroscedasticity. Jarque-Barra test statistics reject that the residuals of Model 4 are normally distributed. The residuals have a median of -2 basis points and a standard deviation of 0.283. Evidence of skew and kurtosis is seen in Figure 12.

Figure 12: Distribution of the Residuals within Model 4 Estimation



Source: Calculated; the x-axis numbers the ranges of the observations in percent; the y-axis measures frequency of observations

Effect of risk appetite regimes

The effect of investor risk appetite regimes on bond yields is well researched, including work by Dungey et al. (2000), Codogno et al. (2003) and Pagano and Thadden (2004). However, time fixed effects also absorb changes in market conditions over time, which challenges the need to include a risk appetite regressor. The VIX index of S&P 500 index volatility has a correlation of 0.188 with the time fixed effects of the second model. Adding the VIX index to the model without time effects in the five State sample makes little difference to the regressors of interest within either the base model (1) or the model with time fixed effects (3).

Table 36: Regression of Yield Spread — VIX Index Added

Estimator	OLS Model 1	OLS Model 3	OLS
Constant	2.504 ***	2.299 ***	2.439 ***
	(0.062)	(0.082)	(0.065)
Municipal Bond Bank	-0.062 ***	-0.069 **	-0.067 ***
	(0.012)	(0.012)	(0.012)
Duration	0.014 ***	0.012 ***	0.013 ***
	(0.002)	(0.002)	(0.001)
Liquidity ($mn)	-0.004 **	-0.004	-0.004 **
	(0.002)	(0.002)	(0.002)
Coupon	0.037 ***	0.042 ***	0.039 ***
	(0.004)	(0.004)	(0.004)
Competitive u/w dummy	-0.273 ***	-0.255 ***	-0.270 ***
	(0.009)	(0.009)	(0.009)
Risk Appetite (VIX Index)	-	-	0.006 ***
			(0.001)
State fixed effects	No	No	No
Time fixed effects	No	Yes	No
Tax controls	Yes	Yes	Yes
Credit rating controls	Yes	Yes	Yes
Number of observations	6,619	6,619	6,619
R-squared	0.508	0.612	0.510

Source: Calculated; key: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Selection bias – propensity score matching

To address possible selection bias within linear regressions, a propensity score matching method is adopted to match bond issues of individual municipalities with those of MBBs. Propensity score methods shift focus from the linear estimation of $E\ [Y_i \mid X_i,\ d_i]$ to estimation of a propensity score: $\text{prob}\ (X_i) = p\ (d_i = 1 \mid X_i) \equiv E\ [d_i \mid X_i]$, where d_i is a treatment dummy and X_i an independent variable.

I estimate a probit model for the propensity of observations to be assigned into the treated group (in this case MBB bond issues) and use X_i variables that may affect the likelihood of being assigned into the treated group.

The propensity score is the conditional predicted probability of receiving treatment, given pre-treatment characteristics, X_i.

Addressing the full data sample of all five States, as a first stage I estimate a propensity score by taking a probit regression of the Mutual (treatment) dummy. These results allow an estimation of the treatment effect on the yield spread to be made.

Table 37: Propensity Score Model (Probit Model)

Dependent variable Mutual dummy	Probit coefficients
Duration	-0.050 ***
Issue size	0.233 ***
Coupon	0.227 ***
Competitive	-0.482 ***
Tax 1	3.747 ***
Tax 3	2.400 ***
Tax 5	3.447 ***
Aaa	13.491 ***
Aa2	11.753 ***
Aa3	10.253 ***
A2	10.204 ***
Number of observations 6,619, log likelihood -1293.3, pseudo R-squared 0.506	

Source: Calculated; Tax 2, Tax 4, Tax 6, Tax 7, Tax 8, Aa1, A1, A3, Baa1, Baa2, Ba2 and Not Rated are omitted, as they are perfect predictors of Mutual; State and monthly fixed effects included; Vermont is excluded from State fixed effects; a number of months are excluded, due to collinearity; constant term suppressed

The omitted credit rating variable is Ba1, which is a lower grade than the other credit ratings included. The omitted tax variable is 'Federal taxable', which is the least attractive tax status. Vermont is omitted from State fixed effects.

The region of common support of propensity scores is between 0.0024 and 0.9839 and the sample is reduced to 2,947 observations, split into eight blocks as follows:

Table 38: Range of Percentiles of Observations

Inferior of block of propensity score	Mutual = 0	Mutual = 1	Total
0	852	18	870
0.1	449	62	511
0.2	210	79	289
0.3	168	117	285
0.4	220	260	480
0.6	83	156	239
0.7	46	117	163
0.8	26	84	110
Total	2054	893	2947

Source: Calculated

Table 39 highlights the average treatment effect of an MBB bond issue from matching by different methods. Each of the average treatment effects on the treated is estimated with time and State fixed effects included.

Table 39: Average Treatment Effect on the Treated (MBB bond issue)

Estimation method	Average Treatment Effect	Standard error
Linear regression with Mutual dummy	-0.086 **	0.014
ATET nearest neighbour	-0.083 ***	0.030
ATET kernel matching	-0.071 ***	0.018
ATET stratification matching	-0.076 **	0.031

Source: Calculated; the difference between the linear regression treatment effect and results from Table 34 is the omission of Tax 2, Tax 4, Tax 6, Tax 7, Tax 8, Aa1, A1, A3, Baa1, Baa2 and Not Rated regressors in the former, which are perfect predictors of Mutual

All results of the effect of participation in an MBB bond issue are significant and lie in close proximity to the results suggested by the models in Table 34. After matching treated and control bond issues, Table 39 claims that the average effect on participants of participation within an MBB bond issue programme is to reduce the yield spread by between 7.1 and 8.3 basis points across all five States.

The control variables in Table 39 differ from those of Table 34: a number of the credit rating and tax status variables are omitted from the former, because they are perfect predictors of the Mutual dummy. Hence the linear regression of Table 39 is not directly comparable with that of Model 4 in Table 34.

Individual State-by-State linear regression results

A panel regression of the large sample fits data from five different States to one set of β and γ coefficients. By contrast, I show below that estimating the effect of a municipality's participation in an MBB bond issue generates β and γ coefficients that differ widely from one State to another. Tables 41 and 40 are constructed with and without time fixed effects respectively.

The MBB dummy is negative and significant in four States in the base OLS model, whereas it is negative and significant in all States, according to time fixed effects models. Significant estimates of the benefit of participating in an MBB bond issue range from 8.2 to 43.3 basis points by individual State and from 5.1 to 40.8 basis points in models that control for time fixed effects. In each State, the Wald test implies that the time fixed effects model is appropriate, by rejecting the null hypothesis that the period coefficients are jointly equal to zero. In every State, the R-squared of the respective regression with time fixed effects is higher than that of the regression for all five States combined.

Benefits from participating in MBB bond issues are least compelling in Alaska: the MBB dummy coefficient is significant at the 5% level when I control for time fixed effects, although the regressor is not significant in the base model. In the fixed effects model, participating in the bond issues of the Alaska Municipal Bond Bank saves 7.4 basis points relative to individual municipality bond issues. Bonds issued by the Maine Municipal Bond Bank save between 8.2 (no fixed effects model) and 15.9 (time fixed effects model) for municipalities relative to bonds issued by individual municipalities. New Hampshire Municipal Bond Bank involvement in new bond issues reduces yield spreads between 5.1 and 9.1 basis points. The MBB dummy within the North Dakota sample is collinear with the AAA credit rating dummy. The effect of the MBB reduces yield spreads by between 40.8 and 43.3 basis points. The MBB effect is significant and negative on yield spread in Vermont, ranging between 32.0 and 39.3 basis points. This is the smallest sample of the five States.

The North Dakota Public Finance Authority and Vermont Municipal Bond Bank generate the greatest interest cost savings of the five MBBs sampled, yet Table 22 shows that they have the lowest values of long-term bonds outstanding on their respective balance sheets among the MBBs studied.

Of the other regressors:

1. Duration is significant at the 1% level in all States and affects yield spread positively in four States, except in North Dakota. In the four States, the effect is between 1.8 and 3.5 basis points per year, which a bond issuer should consider as economically significant.

2. Liquidity (as measured by size of bond issue) is only significant in North Dakota and Vermont, where it impacts yield spreads negatively. Even here, the economic impact is low, given the small size of bond issues.

3. Coupon is a positive and significant regressor in all States (between 1.5 and 11.4 basis points per percent increase in coupon).

4. Competitive underwriting arrangements generate savings of between 8.3 and 41.0 basis points relative to negotiated underwriting for issuers in the four States that record both methods. There are no negotiated arrangements in Vermont.

5. In the base regressions, the higher quality credit ratings regressors that are significant are more negative than the lower credit ratings regressors, relative to Not Rated, in the four States where it is the omitted category.

6. All tax regressors in the base models are significant in Alaska, Maine, New Hampshire and Vermont. Fewer regressors are significant in the fixed effects models. Tax 1 (Federal and State tax exempt) and Tax 2 (Federal bank qualified/State tax exempt) are the most attractive categories and represent 85% of the sample. Their regressors are negative relative to Tax 8 (Federal and State taxable) in each State's base model.

In all models in Tables 40 and 41, the correlations of the residuals against the regressors of interest are zero in each State. Furthermore, there is limited evidence of multi-collinearity between the contemporaneous regressors across the States individually, with the exception of Maine.

Regressions are run by individual State, without and with municipality fixed effects. There are 245 different municipalities and five MBBs across the five States (fixed effects results are not reported). In general, this makes little difference to the regressors of main interest, although it introduces collinearity.

Table 40: Regression of Yield Spread by Individual State

Estimator	Alaska (1)	Maine (2)	New Hampshire (3)	North Dakota (4)	Vermont (5)
Constant	0.521 ***	0.771 ***	0.233 ***	1.356 ***	2.187 ***
	(0.059)	(0.125)	(0.085)	(0.117)	(0.096)
MBB issue dummy	-0.007	-0.082 ***	-0.091 ***	-0.433 ***	-0.393 ***
	(0.020)	(0.027)	(0.021)	(0.082)	(0.046)
Duration	0.028 ***	0.018 ***	0.023 ***	-0.019 ***	0.035 ***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.008)
Liquidity ($mn)	0.001	0.001	0.002	-0.031 ***	-0.052 ***
	(0.001)	(0.001)	(0.006)	(0.005)	(0.019)
Coupon	0.015 **	0.021 ***	0.033 ***	0.069 ***	0.114 ***
	(0.007)	(0.007)	(0.009)	(0.010)	(0.019)
Competitive u/w	-0.083 ***	-0.204 ***	-0.231 ***	-0.410 ***	-
	(0.023)	(0.014)	(0.022)	(0.025)	-
Tax 1	-0.131 ***	-0.396 ***	-0.160 ***	-0.634 ***	-0.246 ***
	(0.036)	(0.078)	(0.045)	(0.087)	(0.069)
Tax 2	-	-0.482 ***	-0.342 ***	-0.739 ***	-
	-	(0.077)	(0.043)	(0.088)	-
Tax 3	0.133 ***	0.163 **	0.128 *	-0.232 **	0.348 ***
	(0.048)	(0.076)	(0.073)	(0.102)	(0.074)
Tax 4	-0.201 ***	-0.306 ***	-	-0.063	-
	(0.041)	(0.098)	-	(0.107)	-
Tax 5	0.593 ***	0.141 *	0.568 ***	0.062	0.283 ***
	(0.080)	(0.083)	(0.047)	(0.143)	(0.084)
Tax 6	-	-0.420 ***	-	-	-
	-	(0.075)	-	-	-
Tax 7	-	-0.628 ***	-	-	-
	-	(0.077)	-	-	-
Tax 8	-	-	-	-	-
	-	-	-	-	-
Aaa	-0.542 ***	-0.519 ***	-	-	-
	(0.064)	(0.104)	-	-	-
Aa1	-0.519 ***	-0.359 ***	-0.183 **	-0.501 ***	-
	(0.046)	(0.103)	(0.079)	(0.077)	-
Aa2	-0.487 ***	-0.414 ***	-0.086	-0.611 ***	-1.910 ***
	(0.048)	(0.102)	(0.077)	(0.083)	(0.081)
Aa3	-0.632 ***	-0.381 ***	-0.106	-0.436 ***	-2.086 ***
	(0.052)	(0.102)	(0.077)	(0.076)	(0.070)
A1	-0.300 ***	-0.103	0.139 *	-0.450 ***	-2.120 ***
	(0.052)	(0.103)	(0.084)	(0.075)	(0.064)
A2	0.144	-0.124	0.445 ***	-0.412 ***	-1.657 ***
	(0.106)	(0.114)	(0.103)	(0.078)	(0.076)
A3	0.007	-	0.667 ***	-0.152 *	-1.814 ***
	(0.049)	-	(0.114)	(0.086)	(0.089)
Baa1	-	-0.069	0.382 ***	0.032	-1.804 ***
	-	(0.110)	(0.085)	(0.111)	(0.070)
Baa2	0.217 ***	-	-	-	-1.502 ***
	(0.071)	-	-	-	(0.089)
No credit rating (NR)	-	-	-	-0.364 ***	-
	-	-	-	(0.080)	-
Number of readings	952	1,827	1,174	2,142	524
R-squared	0.471	0.579	0.699	0.358	0.709

Source: Calculated; key: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Negotiated is the omitted underwriting dummy in all States; Tax 6 and NR omitted in Alaska; Tax 8 and NR omitted in Maine; Tax 6 and NR omitted in New Hampshire; Tax 8 and Aaa omitted in North Dakota (the only Aaa rated issuer in North Dakota is the MBB, the NDPFA); Tax 8 and NR omitted in Vermont; other omissions are due to collinearity or lack of observations

Table 41: Regression of Yield Spread by Individual State with Time Fixed Effects

Estimator	Alaska (1)	Maine (2)	New Hampshire (3)	North Dakota (4)	Vermont (5)
Constant	-0.420 ***	1.301 ***	-0.476 ***	1.069 ***	2.813 ***
	(0.112)	(0.143)	(0.084)	(0.122)	(0.187)
MBB issue dummy	-0.074 **	-0.159 ***	-0.051 **	-0.408 ***	-0.320 ***
	(0.030)	(0.029)	(0.024)	(0.105)	(0.056)
Duration	0.027 ***	0.015 ***	0.022 ***	-0.023 ***	0.059 ***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Liquidity ($mn)	-0.001	0.005	0.004	-0.042 ***	0.007
	(0.002)	(0.005)	(0.005)	(0.007)	(0.015)
Coupon	0.029 ***	0.036 ***	0.053 ***	0.072 ***	0.037 ***
	(0.007)	(0.008	(0.008)	(0.009)	(0.011)
Competitive u/w	0.030	-0.232 ***	-0.298 ***	-0.308 ***	-
	(0.042)	(0.014)	(0.020)	(0.023)	-
Tax 1	0.096	-0.532 ***	-0.072	-0.430 ***	-0.458 ***
	(0.260)	(0.082)	(0.061)	(0.065)	(0.035)
Tax 2	-	-0.612 ***	-0211 ***	-0.585 ***	-
	-	(0.081)	(0.069)	(0.065)	-
Tax 3	0.420 ***	-0.012	0.112	-0.084	0.101 *
	(0.259)	(0.084)	(0.072)	(0.081)	(0.059)
Tax 4	-0.101	-0.464 ***	-	0.139	-
	(0.260)	(0.102)	-	(0.117)	-
Tax 5	0.699 **	-0.022	0.600 ***	0.265 **	0.040
	(0.277)	(0.088)	(0.068)	(0.133)	(0.085)
Tax 6	-	-0.279 ***	-	-	-
	-	(0.097)	-	-	-
Tax 7	-	-0.664 ***	-	-	-
	-	(0.072)	-	-	-
Tax 8	-	-	-	-	-
	-	-	-	-	-
Aaa	-	-0.677 ***	-	-	-
	-	(0.089)	-	-	-
Aa1	0.350 ***	-0.571 ***	-0.189 **	-0.428 ***	-
	(0.105)	(0.088)	(0.081)	(0.097)	-
Aa2	0.523 ***	-0.525 ***	-0.097	-0.379 ***	-2.674 **
	(0.106)	(0.086)	(0.080)	(0.100)	(0.136)
Aa3	0.387 ***	-0.533 ***	-0.062	-0.345 ***	-2.691 ***
	(0.105)	(0.085)	(0.079)	(0.095)	(0.144)
A1	0.567 ***	-0.337***	0.119	-0.317 ***	-2.416 ***
	(0.101)	(0.088)	(0.091)	(0.097)	(0.179)
A2	1.161 ***	-0.309 ***	0.381 ***	-0.283 ***	-2.129 ***
	(0.150)	(0.104)	(0.090)	(0.097)	(0.159)
A3	0.917 ***	-	0.407 ***	0.014	-2.404 ***
	(0.107)	-	(0.099)	(0.102)	(0.122)
Baa1	-	-0.084	0.414 ***	0.153	-1.919 ***
	-	(0.095)	(0.087)	(0.121)	(0.076)
Baa2	0.741 ***	-	-	-	-1.604 ***
	(0.120)	-	-	-	(0.128)
No credit rating (NR)	-	-	-	-0.199 ***	-
	-	-	-	(0.096)	-
Number of readings	952	1,827	1,174	2,142	524
R-squared	0.669	0.705	0.849	0.633	0.908

Source: Calculated; key: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Negotiated is the omitted underwriting dummy in all States; Tax 6 and NR omitted in Alaska; Tax 8 and NR omitted in Maine; Tax 6 and NR omitted in New Hampshire; Tax 8 and Aaa omitted in North Dakota (the only Aaa rated issuer in North Dakota is the MBB, the NDPFA); Tax 8 and NR omitted in Vermont; other omissions due to collinearity or lack of observations

Propensity score matching for individual States

The propensity score matching methodology is repeated for each State individually. All MBB bond issues are included in the average treatment effect calculations in Maine, New Hampshire and North Dakota, although the region of common support of propensity scores excludes some observations in Alaska and Vermont. The latter States have the lowest number of overall observations. The number of control variables in Vermont, in particular, is relatively low. The full sample here is just 525 observations.

Comparing this approach to the linear regressions above, it records similar Municipal Bond Bank treatment effects to the results with time fixed effects of Maine (the average effect of participation within an MBB bond issue programme is to reduce the yield spread by between 17.3 and 19.7 basis points), New Hampshire (between 3.9 and 6.0 basis points) and Vermont (between 38.0 and 42.4 basis points). In North Dakota, the estimated treatment effect (between 15.1 and 20.4 basis points) is lower than that of the linear regression models. In Alaska, this method fails to generate significant results, as is the case in the OLS regression without fixed effects.

The 'linear regression with Mutual dummy' treatment effects in the following tables differ from the Mutual regressors in Table 41, because a number of the credit rating and tax status variables are perfect predictors of the Mutual dummy and are omitted from the latter tables.

Table 42: Average Treatment Effect on the Treated (MBB bond issue) Alaska

Estimation method	Average Treatment Effect	Standard error
Linear regression with Mutual dummy	-0.013	0.022
ATET nearest neighbour	-0.065	0.049
ATET kernel matching	-0.020	0.029
ATET stratification matching	-0.009	0.027
number of MBB observations: nearest neighbour 144, kernel 144, stratification 144; number of control observations: nearest neighbour 52, kernel 95, stratification 95		

Source: Calculated; time fixed effects included

Table 43: Average Treatment Effect on the Treated (MBB bond issue) Maine

Estimation method	Average Treatment Effect	Standard error
Linear regression with Mutual dummy	-0.070 **	0.023
ATET nearest neighbour	-0.173 ***	0.041
ATET kernel matching	-0.184 ***	0.026
ATET stratification matching	-0.197 ***	0.029
number of MBB observations: nearest neighbour 211, kernel 211, stratification 211; number of control observations: nearest neighbour 162, kernel 829, stratification 829		

Source: Calculated; time fixed effects included

Table 44: Average Treatment Effect on the Treated (MBB bond issue) New Hampshire

Estimation method	Average Treatment Effect	Standard error
Linear regression with Mutual dummy	-0.058 ***	0.024
ATET nearest neighbour	-0.044 *	0.032
ATET kernel matching	-0.060 **	0.024
ATET stratification matching	-0.039 *	0.025
number of MBB observations: nearest neighbour 190, kernel 190, stratification 190; number of control observations: nearest neighbour 113, kernel 344, stratification 344		

Source: Calculated; time fixed effects included

Table 45: Average Treatment Effect on the Treated (MBB bond issue) North Dakota

Estimation method	Average Treatment Effect	Standard error
Linear regression with Mutual dummy	-0.307 ***	0.054
ATET nearest neighbour	-0.204 ***	0.077
ATET kernel matching	-0.153 ***	0.054
ATET stratification matching	-0.151 ***	0.055
number of MBB observations: nearest neighbour 107, kernel 107, stratification 107; number of control observations: nearest neighbour 75, kernel 1347, stratification 1347		

Source: Calculated; time fixed effects included

Table 46: Average Treatment Effect on the Treated (MBB bond issue) Vermont

Estimation method	Average Treatment Effect	Standard error
Linear regression with Mutual dummy	-0.555 ***	0.050
ATET nearest neighbour	-0.424 ***	0.125
ATET kernel matching	-0.382 ***	0.119
ATET stratification matching	-0.380 **	0.180
number of MBB observations nearest neighbour 120, kernel 120, stratification 120, number of control observations: nearest neighbour 22, kernel 35, stratification 35		

Source: Calculated; time fixed effects included

CONCLUDING REMARKS

My paper represents a modernisation of the literature in addressing the questions of what drives a municipality to participate in an MBB bond issue and what interest cost savings the credit-pooling agency offers its participants. My key advantage is in creating a much larger and more detailed sample of bond and bond participant data from multiple sources, which give a more accurate input to my empirical work than the small survey-based samples in the existing literature. This is also the first paper to use propensity score matching to refine the samples.

Participating in the bond issuance programme of an MBB has a significant and negative effect on the interest costs of municipal bonds across five different States. Estimates of the MBB participation treatment effect vary by State from marginally beneficial to highly beneficial. OLS regressions and propensity score matching methods give similar estimates of the treatment effect of a US municipality joining MBB bond issue programmes on interest expenses.

With a combined US$20 billion of outstanding bonds issued, credit-pooling represents a small niche of the US municipal bonds market, whose greatest appeal is for smaller municipalities, whose credit is not rated or lower-rated. Its own credit rating (or lack of) and the required bond participation size affect the decision of a US municipality whether or not to join MBB bond issuance programmes.

The interest cost savings of MBB participation seem to be insufficient to convince larger and better credit-rated municipalities to commit to an MBB bond issue programme, when taking into account the greater flexibility for individual municipalities in timing bond issues than participating within a pool of bond issues two to four times per year. Indeed, there are just 10 municipal bond banks across the United States of America and their annual bond issuance represents 0.2% of the total of the US municipal bond market. Only two MBBs have been created this century, which suggests a limited appetite for this business model within the largest municipal bond market in the world.

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CHAPTER 3: DOES FOREIGN CURRENCY BOND ISSUANCE SAVE INTEREST COSTS?

Abstract

Covered Interest Parity (CIP) has not held for many five-year currency pairs since at least 2004. European municipal bond agencies (MBAs) often diversify their bond issuance into foreign currencies on a covered interest rate basis: does this reduce the interest cost of their funding? My data set over 2009-16 suggests that the cross-currency basis for MBAs is often in favour of issuing bonds in foreign currencies, such as the AUD and NZD. The sample achieves average interest cost savings between 20.4 and 23.8 bps, relative to issuing bonds in their respective domestic currencies. MBAs achieve interest cost savings 67% of the time, suggesting there may also be other motivations to issue bonds in a foreign currency. Estimations offer little evidence that MBAs are sensitive to deviations from CIP in timing the issue of foreign bonds, with the exception of the decision to issue in CHF. This presents a puzzle as to why MBAs issue bonds in a currency where the deviation from CIP is often unfavourable and basis spreads, such as with AUD and NZD, are nearly always more attractive?

Keywords: Municipal bond agency; covered interest parity; cross-currency basis swap; currency arbitrage

JEL Classification Numbers: F31, H74

INTRODUCTION

Despite the majority of European MBA bond issuance being made in foreign currencies, this is the only paper to study their foreign currency denominated bond issuance and address the effectiveness of this funding strategy. By hedging their currency exposure, MBAs can establish an interest cost advantage relative to issuing domestic denominated bonds. Even though they have no operating exposure outside their domestic markets, they are active issuers in developed and emerging market currencies. Does this reduce costs for stakeholders or are the agencies simply satisfying the appetite of bond buyers? Diversifying through different maturities, geographies and types of investors may optimise the cost of funding and refinancing risk over the business cycle. I investigate the decision to issue hedged fixed-rate bonds in a foreign currency, and in particular the timing and choice of currency.

Foreign currency bond issuance could require an issuer to take a currency risk. For example, should the denomination currency appreciate over the life of a bond against the issuer's home currency, then the effective coupon and the repayment amount would increase when translated back into home currency. However, European MBAs do not assume currency risk in their foreign currency denominated bond issuance. The agencies always issue on a covered interest rate basis, where their exposure to exchange rate risk on interest payments and capital repayment is hedged over the life of the bond via forward foreign exchange contracts or constant currency basis swaps.

The existing literature identifies that the currency choice of bond issuers is driven by:

1. Interest cost minimisation – arbitrage of the failure of CIP
2. Broadening the investor base
3. Market completeness – access to deeper, more mature markets; availability of interest rate/credit derivatives; information asymmetries
4. Relative regulation – governance, disclosure requirements, taxes

In choosing the currency of bond issuance, European MBAs often seek to exploit failures in CIP between their home currency and that of the bond's denomination. This allows them to issue a bond in a foreign currency more cheaply than had they chosen to issue a bond of the same duration in their own currency at the same time. However, any of motivations 2 to 4 above could imply bond issuance in foreign currencies is undertaken, even where the all-in equivalent interest cost in local currency is not optimal.

The Failure of Covered Interest Parity

The breakdown of the covered interest parity condition allows a bond issuer in a foreign currency to benefit from a risk-free arbitrage profit. CIP requires that the relationship between interest rates and the spot and forward currency values of two different currencies is in equilibrium: i.e. the interest rate differential between two currencies in cash money markets equals the difference between the forward and spot exchange rates. In equilibrium, the locked-in forward rate offsets the changes in value due to the different interest rates and one cannot generate an arbitrage profit by borrowing in one currency and investing in another over a given period. By contrast, uncovered interest parity states that the interest rate differential between two currencies in cash money markets equals the expected change in exchange rates of the two currencies. One cannot lock in the future spot rate today. If the forward exchange rate is an unbiased predictor of the future spot rate, then covered and uncovered interest parity are the same.

Let $y^{\$}_{t,\,t+n}$ and $y_{t,\,t+n}$ denote the n-year risk-free interest rates in US dollars and a given foreign currency respectively

S_t is the spot exchange rate, expressed in units of foreign currency per US dollar and $F_{t,t+n}$ is the *n*-year forward exchange rate, expressed in units of foreign currency per US dollar at time *t*. CIP states that the following relationship should hold:

$$(1 + y^{\$}_{t,\,t+n})^n \,.\, F_{t,\,t+n} = (1 + y_{t,\,t+n})^n \,.\, S_t$$

Intuitively, one would expect that an investor, holding $\$1$ today should own

$(1 + y^{\$}_{t,\,t+n})^n$ US dollars in *n* years' time by investing in US dollars.

Alternatively, he can exchange his dollars into S_t units of a foreign currency and invest in that currency to receive $(1 + y_{t,\,t+n})^n \,.\, S_t$ units of the foreign currency in *n* years' time.

The investor buys a currency forward contract today, which will convert the foreign currency earned into $(1 + y_{t,\,t+n})^n \,.\, S_t \;/\; F_{t,\,t+n}$ US dollars.

If both the domestic and foreign notes are risk-free, barring currency risk, and the forward contract has no counterparty risk and transaction costs, then the two investments are considered to be equivalent and should deliver identical returns. Thus, the CIP condition is a no-arbitrage condition.

A cross-currency basis swap involves the exchange of cash flows linked to floating interest rates that are referenced to interbank rates in two different currencies, plus the exchange of principal in the two currencies at the start and maturity of the swap. At longer maturities, the deviation from long-term CIP is defined by the spread on the cross-currency basis swap as $x_{t,\ t+n}$, where:

$$(1 + y^{\$}_{t,\ t+n})^n \,.\, F_{t,\ t+n} = (1 + y_{t,\ t+n} + x_{t,\ t+n})^n \,.\, S_t$$

The measurement of $x_{t,\ t+n}$ is of interest in my work.

The literature review identifies the channels of the breakdowns in covered interest parity since even before the Global Financial Crisis (GFC). I show that CIP has not held for many five-year currency pairs since at least 2004. Failures of CIP provide potential risk-free savings to the issuing agencies' funding programmes and are the motivation for my core research question, namely: do MBAs exploit lapses in covered interest parity, when issuing bonds in foreign currencies?

I study the agencies' decisions to issue bonds in foreign currency relative to their respective domestic currencies. I focus on five foreign currencies of bond issuance and investigate how the difference between the hedged equivalent domestic rate of the foreign currency of issue and the hypothetical domestic interest rate of the respective issuer (the deviation from CIP) affects the decision to issue in a given foreign currency.

I disaggregate the MBA's issue decision into two steps: firstly, it decides whether to issue a bond; secondly, the choice of currency must be decided on. I investigate both the joint issue and conditional issue decisions by undertaking univariate and multivariable probit regressions on the issue decision and I investigate how successful MBAs are in exploiting the failings of CIP in their choice and timing of foreign currency. Through a multinomial probit regression, I investigate the choice between different currencies.

The paper is divided as follows: Section 2 summarises relevant literature and the channels of CIP failure. Section 3 demonstrates the failure of the Covered Interest Parity condition to hold across a number of currency pairs since 2004. I calculate the MBAs' total interest cost savings and include descriptive data. Section 4 introduces the regression models and results of the timing of bond issuance in foreign currencies by the European MBAs. Section 5 contains concluding remarks. The descriptive background of the European MBAs is discussed within Chapter 1.

LITERATURE REVIEW

Table 47: Summary of Existing Literature on Foreign Currency Debt Issuance

Paper	*Topic*	*Main Results*	*Comments*
Popper (1993)	CIP	Long-term deviations slightly higher than short-term deviations	I concentrate on five-year swap spreads and note the failure of CIP since 2004
Fletcher & Taylor (1994)	CIP	Transaction costs account for deviations from CIP in long-dated markets; CIP failures exist	Transaction costs are priced into interest costs in this paper
Baba & Packer (2008)	CIP	CIP has failed to hold since 2007. US dollar funding shortages hit liquidity in swap markets	This matches my findings from 25 currency pairs
Sushko, Borio et al. (2018)	CIP	Reasons are FX hedging, counterparty risk and dollar funding access	CIP failure is the starting point of my study
Du, Tepper & Verdelhan (2016)	CIP	Deviations from CIP imply large, persistent and systematic arbitrage opportunities	I identify covered swap-based currency arbitrage opportunities
Rime, Schrimpf, Syrstad (2017)	CIP	CIP puzzle stems from funding liquidity differences	CIP failure is the starting point of my study
Cenedese, Della Corte & Wang (2018)	CIP	Relationship of dealer balance sheets with CIP violations	Central banks trade against currency mispricing
McBrady & Schill (2006)	Motivation for foreign currency funding	Strong and consistent evidence that differences in covered and uncovered rates across currencies influence firms' foreign currency bonds composition	They focus on firms, who may have assets and income in foreign currency
McBrady & Schill (2007)	Motivation for foreign currency funding	Deviations from covered interest parity drive choice of currency by sovereign and agency issuers	Their focus is close to mine, given that I study municipal agency issuers
Siegfried, Simeonova and Vespro (2007)	Motivation for foreign currency funding	Cost minimisation, broader investor base, complete markets	They introduce motivation drivers other than swap spreads
Habib & Joy (2008)	Motivation for foreign currency funding	Choice of issuance currency is sensitive to deviations from uncovered interest parity	MBAs do not issue bonds on an uncovered basis
Black & Munro (2010)	Motivation for foreign currency funding in Asia	Deviations from covered interest parity are actively arbitraged by residents of minor currency areas	I study European issuers. They use a probit regression for offshore versus onshore
Gozzi et al. (2012)	How firms use domestic and foreign bond issuance	Debt issues in domestic and international markets have different characteristics	I study domestic and foreign currency fixed coupon, fixed maturity-date bonds
Hale & Spiegel (2012)	Impact of EMU on issuance	A significant rise in euro-denominated issuance by non-financial firms	Euro is a benchmark currency for five of the six agencies
Mizen et al. (2012)	Choice between domestic and foreign currency markets for corporate bonds	Use of probit models finds increased depth of markets influence choice of Asian issuers	Guides to choice of regression models
Claessens, Klingebiel & Schmukler (2007)	Government bond issuance	Smaller economies have smaller domestic currency bond markets and more foreign currency bonds	New Zealand dollar, for example, is an active market for MBAs

Investigating interest rate differentials between the borrowing rates in different countries, I focus on the covered interest parity literature and, in particular, the opportunistic motive to arbitrage the failure of CIP. The European municipal bond market is lightly researched. Furthermore, given little issuance of US municipal bonds in currencies outside the US dollar, there is limited published literature from that country on international municipal bond issues. However, a volume of literature on CIP discusses how price differences across markets are actively arbitraged by corporate, sovereign and agency borrowers. Many corporates have assets or operating cash flows in countries outside of their domicile, in contrast to the MBAs.

The channels of failure of Covered Interest Parity

Deviations from CIP have existed for several years. Popper (1993) constructed long-term arbitrage conditions using currency swaps. She found that long-term financial capital is as mobile as short-term capital and that mean absolute deviations from swap-covered parity are on average about 10 basis points higher among long-term assets than short-term assets. Fletcher and Taylor (1994) found deviations averaging 12-33 basis points in long-dated currency pairs, which they ascribe to transaction costs. While McBrady (2003) claimed that covered interest parity held for short-term interest rates, he suggested that this was not the case for long-term interest rates.

Large cross-currency bases appeared during the Global Financial Crisis, implying a deviation from CIP, as interbank markets were impaired and arbitrage capital became limited. Baba and Packer (2008) claim that while foreign exchange and related derivatives markets are very liquid, the GFC created dollar funding shortages from 2007 for non-US financial institutions, which created shortages of liquidity in swap markets, giving rise to swap market deviations from covered interest parity. Conditions for covered interest parity include minimal transaction costs, a lack of political risk, low credit/counterparty risk, low liquidity risk and low measurement error. A number of these assumptions were challenged during the 2007-08 crisis. The cross-currency basis spreads are a function of perceived relative risk of markets, availability of funding, transaction costs, measurement error and credit or counterparty risk. Baba et al. (2009) show that during the GFC, CIP deviations were driven by banks' counterparty risks and wholesale US dollar funding constraints. Bottazi et al. (2012) argue that CIP deviations arise because of a shortage of US dollar collateral.

The literature shows evidence of the persistent breakdown of the CIP condition since the GFC, even when global foreign exchange markets returned to normal operation. Iida et al. (2016) claim that interest rate differentials replaced measures of banks' credit worthiness as drivers of CIP deviations. Cenedese et al. (2018) look at end-users of FX swap markets and identify that the leverage ratio of major bank dealers, driven by Basel III requirements, is related to wider CIP deviations. For longer duration FX contracts, the widening of the basis is associated with regulatory capital ratios.

Du et al. (2016) investigate CIP arbitrage opportunities in the Libor markets post the GFC, using bonds and repo contracts issued by KfW and other high quality multi-currency issuers. They identify the failure of the CIP condition and observe that deviations increase at quarter-ends, correlate with other fixed income arbitrage spreads and are correlated with nominal interest rate levels in both cross-section and time series analysis. They show Libor bases with an average annualised absolute value of 27 basis points at a five-year time horizon over their 2010-16 sample. By comparison, the average term of my sample is 5.0 years and I cover the period 2009-16. Du et al. show that the CIP condition is systematically and persistently violated among G10 currencies, leading to significant arbitrage opportunities in currency markets since the GFC. They attribute this to costly financial intermediation (bank capital requirements and regulations) and imbalances in funding supply and investment demand across currencies, which may point to why the failure of CIP is not arbitraged away.

Rime et al. (2017) focus on three-month arbitrage opportunities and argue that the failure of CIP results from funding liquidity differences, reflected in the marginal funding rates of the main arbitrageurs. With severe funding liquidity differences, it becomes impossible for FX swap intermediaries to quote prices, such that CIP holds across the full rate spectrum. Despite the prevalence of deviations from covered interest parity, they show that arbitrage profits can only be generated by the largest banks, who are present in funding markets in multiple currencies, face constant funding/liquidity needs and can enjoy risk-less arbitrage opportunities. They identify persistent arbitrage opportunities as an equilibrium outcome from market segmentation.

Sushko et al. (2018) identify the persistence of a cross-currency basis since 2007. Short-term CIP deviations are driven by money market frictions, such as availability of funding, market liquidity and leverage regulation. This is due to concerns about counterparty risk and constrained bank access to wholesale dollar funding, resulting in shifts in demand for FX swaps or currency swaps that drive forward exchange rates away from CIP. Basel III regulation now demands that banks' leverage ratios are at least 3%, restricting their ability to arbitrage CIP. As global banks face significantly higher risk-weighted capital requirements, they can only trade much smaller CIP arbitrage volumes relative to their respective equity than before the GFC. The US Volcker Rule also limits banks' proprietary trading activities, including exchange rate forward and swap contracts, thus reducing liquidity. Reforms of the opaque and segmented over-the-counter derivatives market have set higher capital and minimum margin requirements for cross-currency swaps. Thus, other non-regulated arbitrageurs, such as hedge funds, are finding funding tighter from their prime brokers post the GFC, as they seek leverage.

They find that imbalances in the supply and demand for FX hedging move forward exchange rates out of line with CIP, because financial institutions charge a premium for provisioning of collateral risks associated with exposures to the over-the-counter FX derivatives necessary to support FX hedges. This drives longer term deviations, even in a period of low volatility in markets, and the level of CIP deviations relates to aggregate FX hedging imbalances, due to balance sheet costs on the supply side of FX hedges. They derive a market clearing FX forward rate that shows the channel by which demand for FX hedges affects the pricing of cross-currency basis swaps and prevents CIP from holding.

The motivation for foreign bond issuance – deviations from interest rate parity

It is important to differentiate between bonds issued by companies and those by governments and non-corporate agencies that might not have natural foreign currency cash flows or assets. In the case of the former, Allayannis and Ofek (2001) find that firms issue foreign currency denominated debt as a natural currency hedge against foreign cash flows that arise from foreign operations or income derived in foreign currency. The corporate finance literature also introduces trade-off theory, in which issuers increase total debt relative to equity in order to create cost advantages. This can arise from tax treatment (Newberry and Dhaliwal, 2000), clientele effects (Kim and Stulz, 1988) and interest rate differentials (Graham and Harvey, 2001; McBrady and Schill, 2006; Munro and Wooldridge, 2011).

McBrady and Schill (2006) test an opportunistic motive and arbitrage strategies for foreign currency borrowing. They look at the foreign currency bond issuance of governments and agency issuers, who have cash flows exclusively in their respective local currencies. They conclude that covered and uncovered interest yields across currencies are important to these borrowers in choosing the currency of denomination for international debt. They estimate the average gains to opportunistic covered yield borrowing at 4-18 basis points. These issuers systematically increase the share of bonds in a given currency after periods of relative appreciation. The issue currency of the average bond offering in their sample then depreciates by 149 basis points in the year after issuance – ‘a happy circumstance for an uncovered issuer’.

McBrady et al. (2007) find strong evidence that corporates change the currency composition of their international bond issues to exploit differences in borrowing costs across currencies. By picking the currency with the lowest covered yield (the bond yield spread minus currency swaps), an issuer achieves the lowest ‘all-in swapped’ borrowing costs. Currency shares increase when covered interest yields fall relative to other currencies. They estimate the gains to opportunistic covered yield borrowing are between 2-10 basis points. By contrast, they find little evidence that firms exploit differences in uncovered interest costs. Thus, currency risk aversion is more important than potential gains from cross-currency differences in nominal yields and anticipated depreciation rates.

Munro and Wooldridge (2011) study Asian corporate bond markets and focus on the motivation for swap-covered borrowing in a foreign currency between either risk management or comparative advantage. They find that the characteristics of foreign currency bonds issued by residents and local currency bonds issued by non-residents are different. The great proportion of foreign currency debt is swapped back into local currency directly by borrowers as a cost-effective means of raising local currency funding. Issuers systematically respond to estimated deviations from covered interest parity. Imperfections causing these opportunities include transaction costs, agency and information problems, non-traded assets (incomplete markets) and regulations.

Other motives for foreign currency choice

Chinn and Ito (2000) refer to broader market depth, maturity and institutions in certain bond markets, arguing for larger-sized foreign issues if an issuer is based in a small currency market (e.g. the Nordic issuers) and smaller sized issues if the issuer is based in a large currency market (e.g. euro based issuers). They focus on instruments, including market size and bond market turnover as measures of relative market choice. Siegfried et al. (2007) investigate the motives for bond issuance in foreign currency and determinants of the choice of currency of non-financial corporations in advanced economies. They use a conditional logit model to investigate the log odds that a firm chooses to issue in domestic or foreign currency and then, in the case of a foreign currency choice, a nested logit model to identify which particular foreign currency is chosen. They find that cost minimisation, hedging motives, the desire to establish a broader investor base and market regulation influence the choice of currency. An issuer seeks particular markets for longer duration bond issuance.

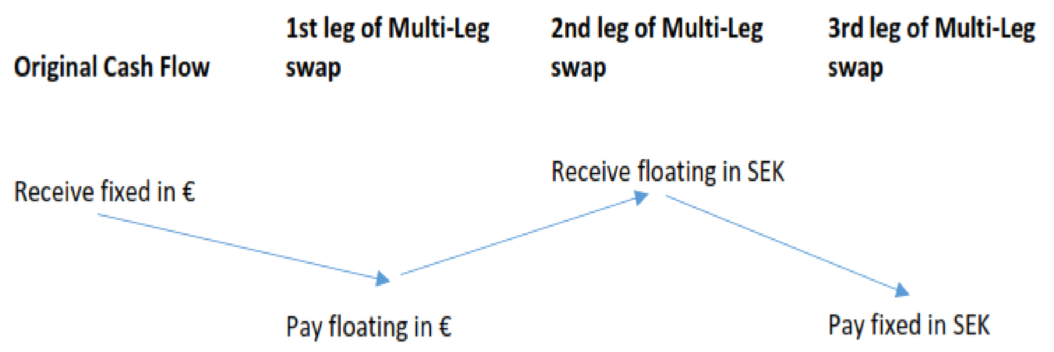
Black and Munro (2010) argue that residents of smaller markets issue swap-covered foreign currency bonds to arbitrage price differentials, to access foreign investors, and to issue larger or longer-maturity bonds. They find that deviations from CIP parity are actively arbitraged; and issuers benefit from the liquidity and diversification of larger 'more complete' offshore markets. They use a probit model and discover that the propensity to issue a bond offshore is related to price arbitrage, certain bond characteristics (e.g. size and tenor), bond market characteristics (e.g. liquidity) and macroeconomic variables. Mizen et al. (2012) look at corporate bond markets in Asia and include size of the foreign investor base and development of the local derivatives markets as instruments. They find that the choice between the onshore and offshore market is driven by the increased depth of the offshore market. The authors' use of probit models to evaluate issuance decisions and the choice between onshore and offshore issuance provides guidance to my work. Hale and Spiegel (2012) use a multinomial logit specification to analyse the impact of the launch of the EMU on the currency denomination of private bond issuance over 1990-2006. They discover a significant rise in euro-denominated issuance and a decline in international dollar-denominated issuance by non-financial firms outside of the Euro Area or the US.

MBAs DIVERSIFY THEIR SOURCES OF ISSUANCE

Deviations from long-term covered interest parity can be large and time persistent. If CIP fails, the MBAs can lock in forward rates today to their advantage, when borrowing in a foreign currency. A bond issuer might use foreign exchange swaps for shorter-dated issuance, although it is normal for multi-leg interest rate and cross-currency basis swaps to be used for maturities of more than one year.

While European agencies budget a funding level to match their lending programmes, there is often a difference between the timing of funding and lending. Thus, when they swap the cash flows of a multi-leg swap from a foreign currency into local currency, they often allow the cash flows to accrue at a floating interest rate in their domestic currency. This addresses the interest rate risk from timing differences between the cash inflows from the bond issue receipts and outflows of the funds being loaned to member SNGs. For the purposes of my analysis, I include the third leg interest rate swap from floating- to fixed-rate in local currency, because I want to calculate the actual local currency equivalent fixed rate achieved relative to a hypothetical fixed rate of the same duration.

Figure 13: Schematic of a Cross-currency Basis Swap from euro to SEK



Source: Author

A cross-currency basis swap spread at the time of bond issue protects the issuer from future changes in floating interest rates and currency movements on redemption and is embedded in the hedge. As an example, Figure 13 demonstrates the cash flows for a Swedish agency that issues a euro denominated fixed coupon bond. The proceeds of the bond issue accrue to the agency in euros at a fixed rate of interest. The agency now swaps those cash flows into a euro floating rate (the first leg of the multi-leg swap) in order to undertake a floating-rate to floating-rate cross-currency swap (the second leg) from euros to Swedish krone. The agency may then decide to leave the cash flows in SEK-denominated floating rate or to undertake a third leg swap from SEK floating to fixed rate. This third leg defines the effective local currency fixed interest rate to the agency. By comparing this rate to what the agency might pay to issue an equivalent duration Swedish krone bond, I can calculate the cost saving that accrues from issuing in a foreign currency relative to issuing in domestic currency. If the CIP condition applies, the difference should be zero.

I illustrate this with a live example in Table 48. Swedish MBA, Kommuninvest, has issued a collateralised 7-year 2% coupon fixed rate, fixed maturity-date bond in euros on 4th October 2011. The exchange rate on the curve date (normally two working days before the swap valuation date) was SEK 9.2025 = €1. The issuing agency wants to secure this exchange rate over the life of its bond, thus eliminating exchange rate risk from future coupon payments and maturity repayment obligations. I assume a €10,000,000 notional value for the purposes of the example. The third column shows the annual coupon payments (in euros) on their respective annual due dates. The interest payments and maturity notional are discounted back to a present date value, using the euro OIS curve. Column 5 sums the resulting present value of the future cash flows to €10,729,679.

The first swap is a fixed- to floating-rate interest rate swap in euros (receiving to pay). Floating-rate payments are calculated quarterly. Taking the curve date for the swap at 30th September 2011, column 6 uses the euro versus 3-month Euribor swap curve. Matching the present day value of the fixed- and floating-rate cash flows gives a -9.4 basis point interest rate swap spread on a 2% fixed-rate. This implies the floating rate interest payments of column 8, which are discounted back to the present day by the euro OIS curve. The resulting stream of present day value floating rate coupons and maturity amount are in column 10, totalling €10,729,679.

The cross-currency swap (paying to receive) exchanges the euro floating-rate cash flows into SEK floating rate cash flows, using the SEK versus euro basis curve. The adjustment for the cross-currency basis swap spread is +33.2 basis points. The resulting floating rate is shown in column 11. The SEK floating rate interest payments are calculated in column 12 and are discounted back to present values by using the SEK OIS curve. The resulting SEK cash flows have a present value of SEK 98,878,912, which is equivalent to €10,744,775 at the exchange rate of 4th October 2011.

To calculate the effective SEK fixed rate of interest on the bond, I must swap the SEK floating rate cash flows into fixed rate cash flows (receiving to pay). This is the reverse of the first swap, albeit this time in Swedish krone. I use the SEK versus 3-month STIBOR swap curve and discount to present values with the SEK OIS curve. The swap spread used is the +33.2 basis points that is generated from the cross-currency swap above. Solving for this backs out an effective annual SEK fixed-rate coupon of 2.713%. As a cross check, it can be seen from columns 19 and 20 that the discounted fixed coupon rates translate from euros to Swedish krone at a constant rate of SEK 9.2025 = €1, which is the same exchange rate as at the start of the swap contract.

The example of Table 48 shows that by issuing a euro-denominated 2% 7-year fixed coupon bond in September 2011 the Swedish agency has locked in an effective fixed coupon of 2.713% in its domestic currency. Is this a good interest rate relative to what the agency might have been able to issue at in krone on the same terms on the same day? The Kommuninvest 2% 7-year bond has a duration of 6.5 years in krone. The OLS regression model of Chapter 1 estimates that on the curve date of the swap the MBA's yield spread over the Swedish sovereign yield curve was 85.1 basis points. The Swedish zero-coupon sovereign curve on 30th September 2011 has a yield-to-maturity of 1.602% for this duration. Adding the yield spread to this implies that Kommuninvest might have issued a bond in krone at a fixed coupon of 2.453% at this time. Thus, the agency has issued the bond in euros 26 basis points above the equivalent fixed rate that it might have issued at in its domestic currency – a relatively expensive bond issue.

This raises a number of questions:

- Do the agencies seek more favourable swap rates to optimise the timing of their foreign currency bond issuance?
- How often do the agencies save interest costs when issuing in foreign currency?
- Are there currencies that are more favourable to issue in?
- Why do agencies issue bonds in foreign currency when they do not save interest costs?

Table 48: Cross-currency Basis Swap Example of a Live Bond Issue

Kommuninvest 2% 7-year euro fixed coupon bond issue, issued in October 2011

Discounted Cashflows launch 04/10/2011	RECEIVE Leg 1 EUR Fixed coupon	EUR fixed Leg 1	Discount rate Leg 1	EUR fixed Leg 1 discounted	PAY Leg 2 euro vs 3m EURIBOR swap rate	Leg 2 Swap adjusted	EUR floating Leg 2	discount rate Leg 2	EUR floating Leg 2 discounted	RECEIVE Leg 3 SEK vs 3m STIBOR swap rate	SEK floating Leg 3	discount rate Leg 3	SEK floating Leg 3 discounted	Leg 3 in euros discounted	PAY Leg 4 implied SEK Fixed coupon	SEK fixed Leg 4	discount rate Leg 4	SEK fixed Leg 4 discounted	Leg 4 euros discounted
04/10/2011	-	**10,000,000**					**10,000,000**				**- 92,025,115**					**92,025,115**			
04/01/2012					1.586%	1.492%	- 37,301	0.9982	**- 37,235**	2.908%	669,029	0.9949	**665,585**	**72,326**					
04/04/2012					1.219%	1.124%	- 28,110	0.9970	**- 28,024**	2.321%	534,057	0.9906	**529,063**	**57,491**					
04/07/2012					1.135%	1.041%	- 26,026	0.9959	**- 25,920**	2.139%	492,195	0.9872	**485,871**	**52,798**					
04/10/2012	2.000%	200,000	0.9950	**198,997**	1.125%	1.031%	- 25,767	0.9950	**- 25,638**	2.108%	485,002	0.9837	**477,095**	**51,844**	2.714%	- 2,497,239	0.9837	**- 2,456,529**	**- 266,941**
04/01/2013					1.126%	1.032%	- 25,795	0.9935	**- 25,628**	2.108%	484,953	0.9797	**475,101**	**51,627**					
04/04/2013					1.148%	1.053%	- 26,334	0.9920	**- 26,124**	2.093%	481,424	0.9758	**469,768**	**51,048**					
04/07/2013					1.217%	1.122%	- 28,056	0.9906	**- 27,793**	2.165%	497,984	0.9719	**483,981**	**52,592**					
04/10/2013	2.000%	200,000	0.9891	**197,817**	1.315%	1.220%	- 30,505	0.9891	**- 30,172**	2.242%	515,842	0.9680	**499,315**	**54,259**	2.714%	- 2,497,239	0.9680	**- 2,417,232**	**- 262,671**
06/01/2014					1.460%	1.365%	- 34,129	0.9872	**- 33,694**	2.375%	546,432	0.9639	**526,733**	**57,238**					
04/04/2014					1.542%	1.448%	- 36,200	0.9854	**- 35,672**	2.226%	512,169	0.9603	**491,837**	**53,446**					
04/07/2014					1.656%	1.562%	- 39,042	0.9835	**- 38,398**	2.403%	552,951	0.9565	**528,907**	**57,474**					
06/10/2014	2.011%	201,111	0.9814	**197,375**	1.775%	1.681%	- 42,026	0.9814	**- 41,245**	2.562%	589,406	0.9526	**561,491**	**61,015**	2.729%	- 2,511,113	0.9526	**- 2,392,186**	**- 259,949**
05/01/2015					2.055%	1.961%	- 49,027	0.9793	**- 48,011**	2.603%	598,819	0.9489	**568,229**	**61,747**					
07/04/2015					2.180%	2.086%	- 52,138	0.9770	**- 50,938**	2.902%	667,750	0.9452	**631,144**	**68,584**					
06/07/2015					2.233%	2.138%	- 53,461	0.9749	**- 52,120**	2.910%	669,566	0.9416	**630,431**	**68,506**					
04/10/2015	1.994%	199,444	0.9728	**194,015**	2.354%	2.259%	- 56,487	0.9728	**- 54,949**	3.013%	693,150	0.9379	**650,115**	**70,645**	2.706%	- 2,490,302	0.9379	**- 2,335,689**	**- 253,810**
04/01/2016					2.459%	2.365%	- 59,113	0.9701	**- 57,344**	2.847%	654,968	0.9343	**611,939**	**66,497**					
04/04/2016					2.554%	2.460%	- 61,491	0.9673	**- 59,478**	2.890%	664,908	0.9307	**618,843**	**67,247**					
04/07/2016					2.647%	2.553%	- 63,823	0.9644	**- 61,548**	2.932%	674,637	0.9272	**625,500**	**67,971**					
04/10/2016	1.994%	199,444	0.9613	**191,731**	2.768%	2.674%	- 66,847	0.9613	**- 64,262**	3.007%	691,747	0.9236	**638,896**	**69,426**	2.706%	- 2,490,302	0.9236	**- 2,300,038**	**- 249,936**
04/01/2017					2.764%	2.669%	- 66,730	0.9584	**- 63,956**	3.078%	708,207	0.9201	**651,592**	**70,806**					
04/04/2017					2.784%	2.690%	- 67,246	0.9555	**- 64,254**	3.053%	702,307	0.9166	**643,749**	**69,954**					
04/07/2017					2.892%	2.797%	- 69,934	0.9525	**- 66,612**	3.127%	719,505	0.9132	**657,033**	**71,397**					
04/10/2017	2.000%	200,000	0.9494	**189,876**	3.000%	2.906%	- 72,641	0.9494	**- 68,964**	3.203%	736,788	0.9097	**670,265**	**72,835**	2.714%	- 2,497,239	0.9097	**- 2,271,768**	**- 246,864**
04/01/2018					2.887%	2.793%	- 69,816	0.9464	**- 66,073**	3.137%	721,802	0.9063	**654,153**	**71,084**					
04/04/2018					2.886%	2.791%	- 69,787	0.9434	**- 65,839**	3.100%	713,178	0.9029	**643,959**	**69,976**					
04/07/2018					2.976%	2.881%	- 72,033	0.9404	**- 67,738**	3.165%	728,104	0.8996	**654,999**	**71,176**					
04/10/2018		10,200,000	0.9372	**9,559,868**			- 10,074,291	0.9372	**- 9,442,048**		92,758,081	0.8962	**83,133,317**	**9,033,764**	2.712%	- 2,496,013	0.8962	**- 2,236,927**	**- 243,078**
																- 92,020,233	0.8962	**- 82,468,533**	**- 8,961,525**
			PV	**10,729,679**				**PV**	**- 10,729,679**			**PV**	**98,878,912**	**10,744,775**	**2.713%**		**PV**	**- 98,878,903**	**- 10,744,774**

Source: Bloomberg, calculated

How many bonds do European MBAs issue in foreign currency?

Throughout this paper, I concentrate on foreign, single-currency denominated, fixed coupon, fixed maturity-date bonds. Fixed income bonds represent approximately 85% of all bond issuance of the six largest European MBAs. The balance includes bonds with floating-rate coupon, callable/puttable redemption features or equity structured payoffs within their maturity profile, and bonds with multi-currency features to the coupon or maturity profile of foreign currency bonds. The latter are popular via Uridashi bond issues with Japanese investors, who seek higher nominal coupons than they are able to derive in yen-denominated bonds. The bond buyer might be currency hedged, but the issuer is always fully hedged. Furthermore, the practice of the MBA issuers is always to collateralise their bond issues.

The six major MBAs had total bonds outstanding worth €271.9 billion at the end of 2016. With live Medium Term Note programmes worth a combined €250 billion, they are active issuers of foreign currency bonds. I estimate that foreign-currency denominated bonds account for 67.3% of all their bonds outstanding by value at the end of 2016. Respective report & accounts summarise the outstanding total bond issuance by currency of NWB, Kommuninvest, MuniFin and Kommunekredit at the end of 2016. Neither BNG nor KBN publish detailed currency analysis of their bonds outstanding. However, they do provide a breakdown of their gross issuance year-by-year. Proxying their percentage of bonds outstanding by the percentage of bonds issued in 2016, I estimate an approximate geographical split of bonds outstanding below:

Table 49: Bonds Outstanding by Currency Denomination at End 2016

€ billion	6 MBAs estimated	4 MBAs ex BNG & KBN actual	Share of 6 MBAs estimated
EUR	74.2	29.9	27.3%
USD	121.8	57.9	44.8%
JPY	11.5	7.8	4.3%
CHF	10.4	6.6	3.9%
AUD	6.6	5.4	2.4%
GBP	14.8	8.9	5.5%
Other	32.6	23.5	12.0%
Total	271.9	140.0	100.00%

Source: MBA report & accounts

The euro-based MBAs account for a combined €65.6 billion of the estimated euro-denominated bonds outstanding, which is thus domestic currency issuance. USD is by far the largest foreign currency of issuance.

Between 2009 and 2016, the six agencies issued 1,435 fixed-coupon, fixed maturity-date bonds in 24 different currencies. Many of the 597 issues denominated in BRL, IDR, INR, MXN, TRY and ZAR are Uridashi bonds, which are small in size. These dual-currency bonds may pay income or a redemption amount, denominated in a third high-yielding currency. I exclude these bonds from my analysis, due to multi-currency features or lack of cross-currency basis swap data.

Table 50: European MBA Fixed Coupon and Fixed Maturity Bonds Issued, 2009-16

Currency	Number (domestic)	Number (foreign)	Currency	Number (domestic)	Number (foreign)
AUD	-	157	BRL	-	203
CHF	-	68	CAD	-	13
DKK	10	-	CLP	-	7
EUR	110	23	CNY	-	1
GBP	-	28	EGP	-	1
JPY	-	48	HKD	-	31
NOK	19	39	IDR	-	55
NZD	-	72	INR	-	70
SEK	25	15	MXN	-	30
USD	-	166	NGN	-	1
			PLN	-	2
			RON	-	2
			TRY	-	107
			ZAR	-	132
Sub total	164	616		-	655

Source: Bloomberg; key – BRL Brazilian real; CAD Canadian dollar; CLP Chilean peso; CNY Chinese yuan; EGP Egyptian pound; IDR Indonesian rupiah; INR Indian rupee; MXN Mexican peso; NGN Nigerian naira; PLN Polish zloty; RON Romanian leu; TRY Turkish lira; ZAR South African rand

All of the currencies in the left hand columns of Table 50 are single-currency bonds. Four of these currencies lack sufficient observations for my regression analysis. I also exclude many JPY-denominated bonds, as they have pay-offs that are linked to equity structures (e.g. if a reference company X's stock price follows a certain path, the bond redemption pay-off is Y, otherwise the pay-off is Z). I concentrate upon the following major currencies (76.6% of the third column by number) and the HOME currency option in regressions.

Table 51: Fixed Coupon/Fixed Maturity Bonds, 2009-16, Selected Currencies

Currency	Number	Issuer	Number
AUD	157	BNG	161
CHF	68	KBN	113
HOME	164	Kommunekredit	55
JPY	9	Kommuninvest	98
NZD	72	MuniFin	117
USD	166	NWB	92
Sub total	636		636

Source: Bloomberg

Foreign currency fixed coupon, fixed maturity bond issuance represents 472 bonds in five currencies in my sample. In general, foreign currency bond issues are smaller than domestic currency issues. The average size of a foreign currency bond issue is €366m and the median size is €121m, with 46 issues valued in excess of €1 billion. This compares with the average size of a domestic currency bond of €739m over the period.

Do the MBAs save money by issuing in foreign currencies?

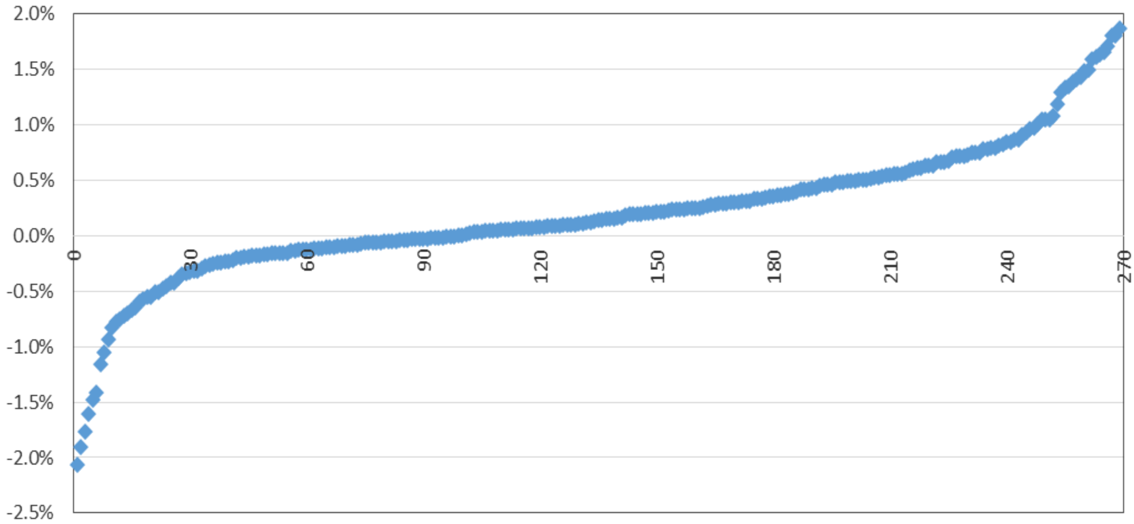
The six MBAs issued 1,271 foreign currency fixed coupon, fixed maturity-date bonds over 2009-16 in 23 different currencies. I restrict the descriptive sample to single-currency bond issues in those currencies that publish interest rate swap and cross-currency basis swap data. I also exclude bonds with equity-linked redemption payoffs. I sample 270 bonds, which is approximately 35% of the available field.

I calculate the equivalent domestic currency coupon, duration and yield-to-maturity of a foreign currency bond at issue by the process defined on pages 133-135. To compare this to the yield-to-maturity of a hypothetical bond, issued in the domestic currency on the same day of issue, I use the regression results from Chapter 1 to calculate a yield spread for each bond to the local sovereign yield curve. By definition, there are no price data for a bond one month before it is issued, so I do not include lags of the dependent variable in the estimation. Furthermore, the regressions of Chapter 1 are based on a 2010-15 sample, so there are no time fixed effects coefficients for 2009 or 2016. I therefore use its regression Model 1 with issuer fixed effects.

Referring to the domestic sovereign zero-coupon yield curve on the relevant curve date, I take the fitted yield of the equivalent duration to the foreign currency bond issue and add the issuer's calculated yield spread from the regression model. I then calculate a spread from the equivalent local currency yield-to-maturity of the foreign currency bond and the hypothetical domestic yield.

This yield spread indicates whether the foreign currency bond issued by the MBA was more or less expensive in terms of interest cost than a local currency bond issued on the same terms on the same day would have been. I repeat the exercise undertaken for the Kommuninvest 2% 7-year euro-denominated bond. Figure 14 summarises the interest cost range of the foreign currency bond issues compared with the interest cost, had they been issued in their respective domestic currency:

Figure 14: Bond Issues' YTM Relative to Domestic Currency Equivalent Yields



Source: Bloomberg, calculated. The x-axis represents a bond number; bonds are organised in order of relative interest cost cheapness to their domestic currency equivalent. A minus value shows that the bond is issued expensively to an equivalent domestic currency bond, a positive value shows that it is issued cheaply to an equivalent domestic currency bond

Some 181 foreign currency bonds (67.0%) are issued more cheaply than their duration-matched domestic equivalent yield-to-maturity, whereas 89 bonds (33.0%) are more expensive. On average a foreign currency bond is issued between 20.4 and 23.8 basis points cheaper than the domestic currency equivalent. The range depends on whether I take the foreign currency bond duration or the domestic currency equivalent bond duration as the reference point on the domestic sovereign yield curve. The median covered interest cost differential is between 14.3 and 15.6 basis points lower. In general, the AUD and NZD appear most often as cheap currencies in which to issue. Of the smaller currencies, when the agencies issued single-currency bonds denominated in IDR, MXN, TRY and ZAR, they always issued cheaply to their respective domestic equivalent yields.

Bid-offer spreads in the swaps market

In order to cross check the accuracy of my calculations, I construct a reverse direction trade, in which I assume a bond is issued in the local currency at the implied equivalent local currency coupon and then reverse the above process to calculate an implied coupon in the actual currency of issue. As well as eliminating errors from the 270 calculations, this has the by-product of extracting the bid-offer spreads that are priced within the markets. For example, the 2% 7-year Kommuninvest bond in Table 48 has an implied equivalent Swedish krone coupon of 2.713%. If I conversely assume that Kommuninvest were to issue a 2.713% 7-year fixed rate bond in SEK, I calculate that the implied equivalent coupon in euros is 2.043%. In other words, the market's bid-offer spreads between paying and receiving swaps has extracted 4.3 basis points from the round trip. The market cost of the one direction multi-leg swap is 50% for this bond, which equals 2.15 basis points and is buried within its price. Such calculations ignore intermediaries' actual trader pricing axes, which are their privileged information. Across the sample of 270 bonds, the round-trip mean average bid-offer difference is 7.3 basis points, which implies the market cost for a one direction trade is 3.65 basis points. The median one direction cost is 2.16 basis points. The bid-offer spreads of IDR and TRY swaps are much higher than those of other currencies. Excluding swaps that are denominated in these currencies reduces the mean market bid-offer cost for a one direction trade to 1.36 basis points.

A benchmark for the MBAs' foreign currency cost savings

The MBAs could decide to issue all of their bonds in their respective domestic currency. That is what the US Municipal Bond Banks do. In this case, there would be no interest cost savings to discuss. On the other hand, they could issue all of their foreign currency bonds in AUD or NZD, which are shown to be cheap relative to the relevant European currencies almost all of the time. With carefully timed bond issuance, the MBAs would make interest costs savings all of the time, but their international bond issuance programme would not then be very diversified.

My results regarding MBAs' average interest savings are in-line with those of Du et al. (2016), who include estimates on high quality KfW bond issues (the German State-owned development bank with an annual bond issuance of €70 billion) over a similar time period. Some MBAs have much higher success rates in generating interest savings than others (see page 151). Focusing upon short-term trading, Rime et al. (2017) argue that only the top-tier banks are able to undertake CIP arbitrage opportunities all of the time.

While a benchmark for the success rate of foreign currency municipal bond issuance is somewhat subjective, it is worth asking why the MBAs issue foreign currency bonds in a relatively expensive currency 33% of the time. Alternative motivations are discussed at the end of the chapter.

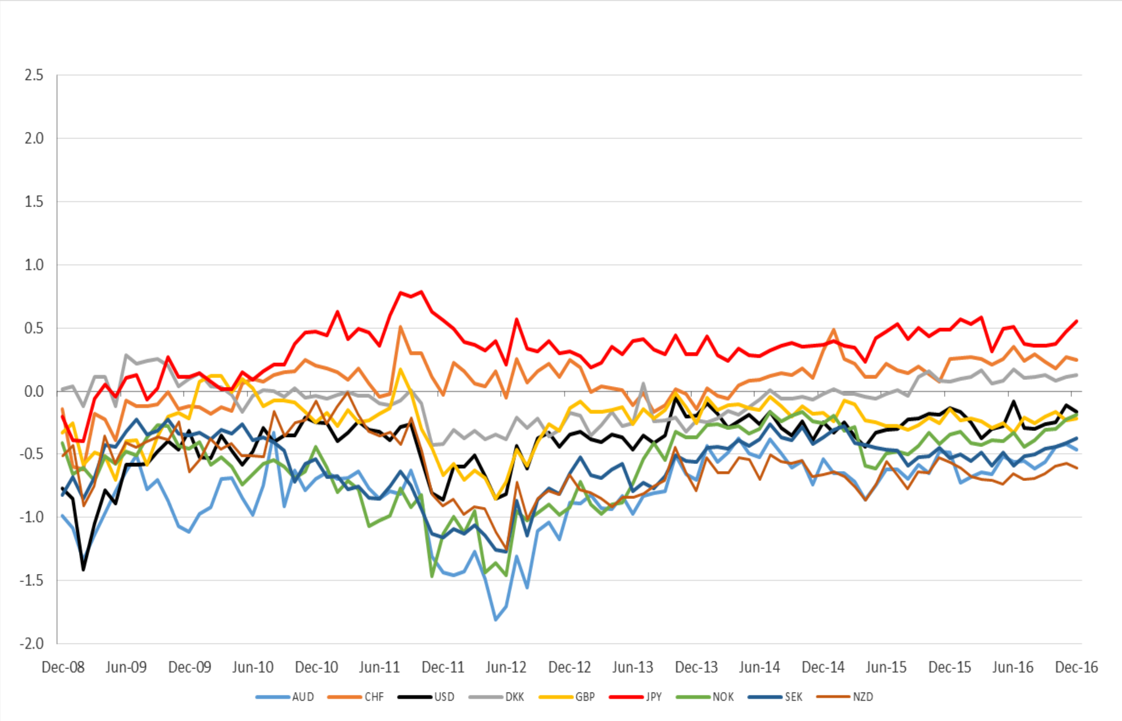
Comparing five-year sovereign bond yields

To give a setting for the above results, I investigate how the covered interest cost differential of target foreign currencies evolves over time. I compare the sovereign bond yields of the major currencies on a covered interest parity basis, with particular interest in the sovereign bond yields of the major currencies AUD, CHF, DKK, EUR, GBP, JPY, NOK, NZD, SEK and USD. There are three issuing agencies within the Euro Area. Thus, I include the sovereign bond yield curves of Finland and the Netherlands, in order to compare with respective domestic equivalent yields. Furthermore, if the euro is seen as a possible currency of issue by a non-euro based agency, then it is likely that the issuer will be interested in the lowest risk and therefore lowest yielding Euro Area market for a relatively cheap cost of issuance. Thus, I also include the German sovereign yield curve.

The median duration of foreign currency fixed coupon bond issuance by European MBAs is 4.9 years over the period of this study. I construct five-year basis swap spreads for a sovereign issuer against nine different currency pairs (as defined above). For example, as a comparison with the Kommuninvest example in Table 48, on 30th September 2011 the five-year point on the German (euro) yield curve had a yield-to-maturity of 1.163%. Undertaking the multi-leg cross-currency basis swap, defined in Figure 13, I calculate that the equivalent five-year SEK fixed rate is 1.969%. Inspection of the Swedish sovereign curve on that date shows that the five-year point on the Swedish zero-coupon yield curve, in fact, had a yield to maturity of 1.459%. Thus, it was 51 basis points more expensive for a Swedish sovereign issuer to issue a five-year fixed coupon bond in euros on that date, relative to issuing a hypothetical bond in its own currency. This is confirmed by inspection of the generic five-year SEK-EUR curve within Figure 19 (the purple line). This result is higher than the actual outcome for the Kommuninvest 2% bond, which has a 6.5 year duration (see discussion on page 135). Differences in live MBA bond issue pricing to five-year reference bonds may also be due to market-makers' pricing axes.

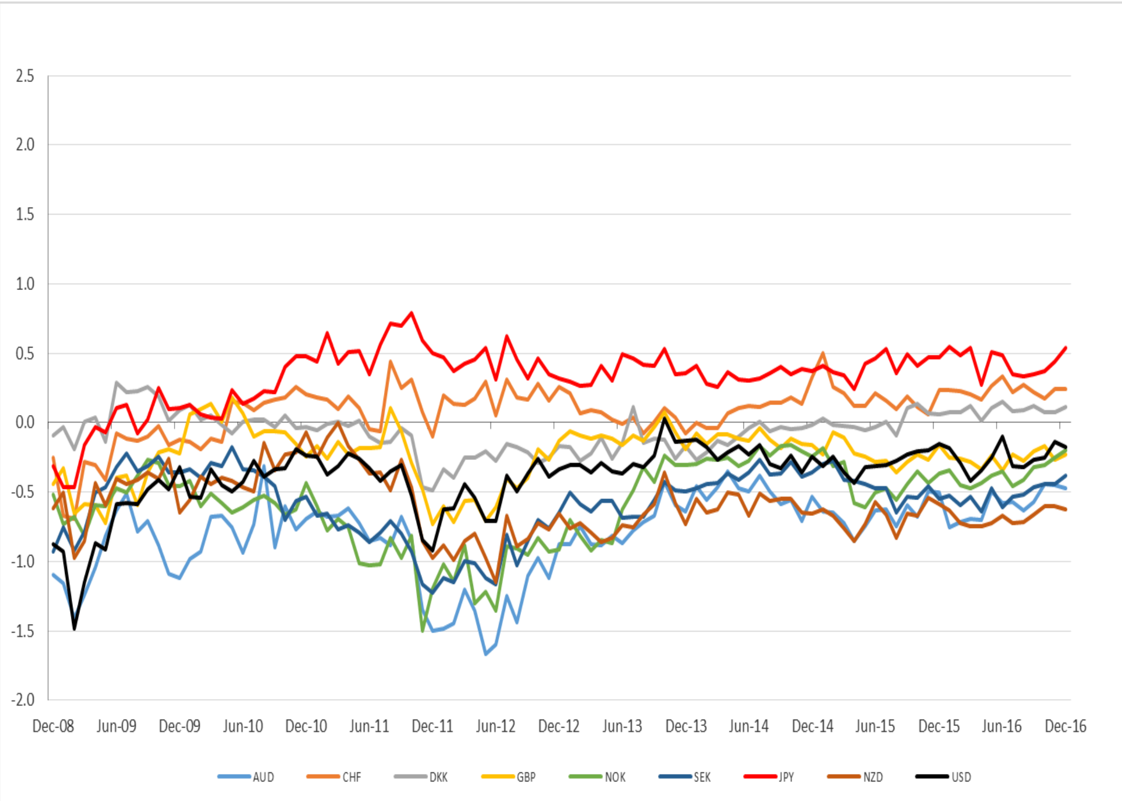
If Covered Interest Parity were to hold, one would expect the equivalent five-year SEK fixed rate and the actual yield-to-maturity of the Swedish sovereign curve to track closely over time. In fact, the following charts demonstrate that this is not the case. All charts from Figures 15 to 19 inclusive are drawn on the same scale, which contrasts swap spreads across different issuers. The data are calculated on a currency-hedged basis. In effect, they are highlighting the deviation from Covered Interest Parity for the various currency pairs. A negative spread indicates that a particular currency is cheap to issue in relative to the domestic currency of the issuer.

Figure 15: 5-year Cross-currency Deviations from CIP to the Dutch Sovereign Curve



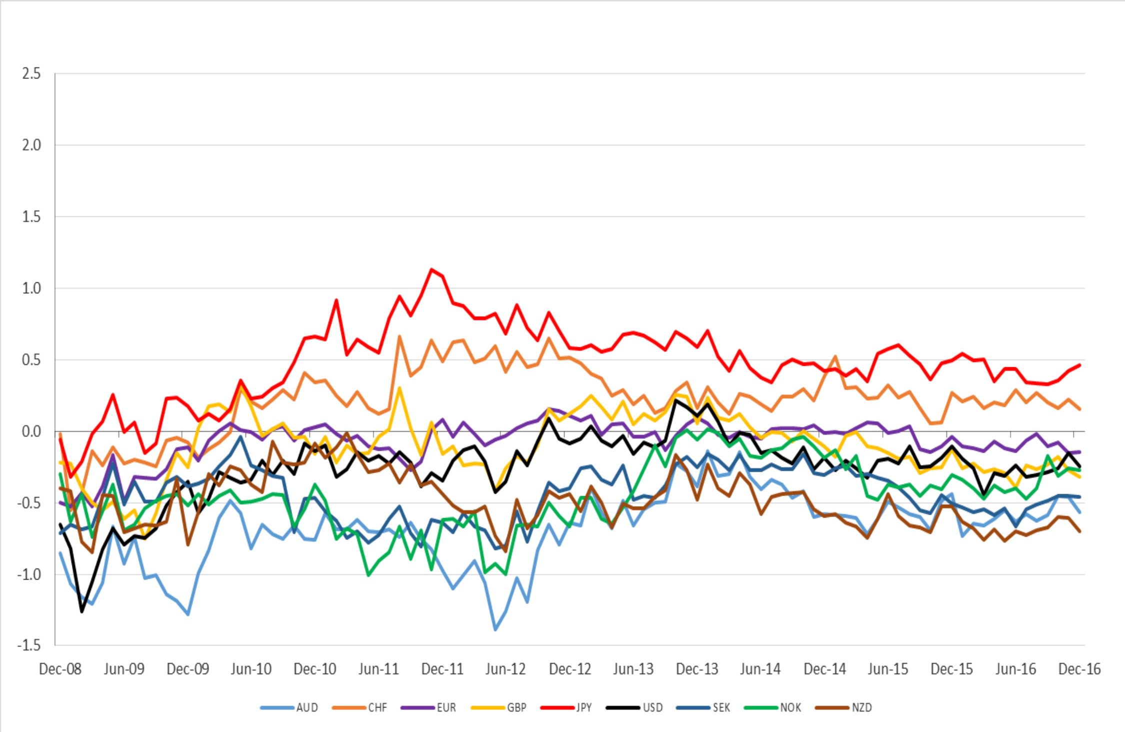
Source: Bloomberg, calculated; units of the y-axis are measured as percent

Figure 16: 5-year Cross-currency Deviations from CIP to the Finnish Sovereign Curve



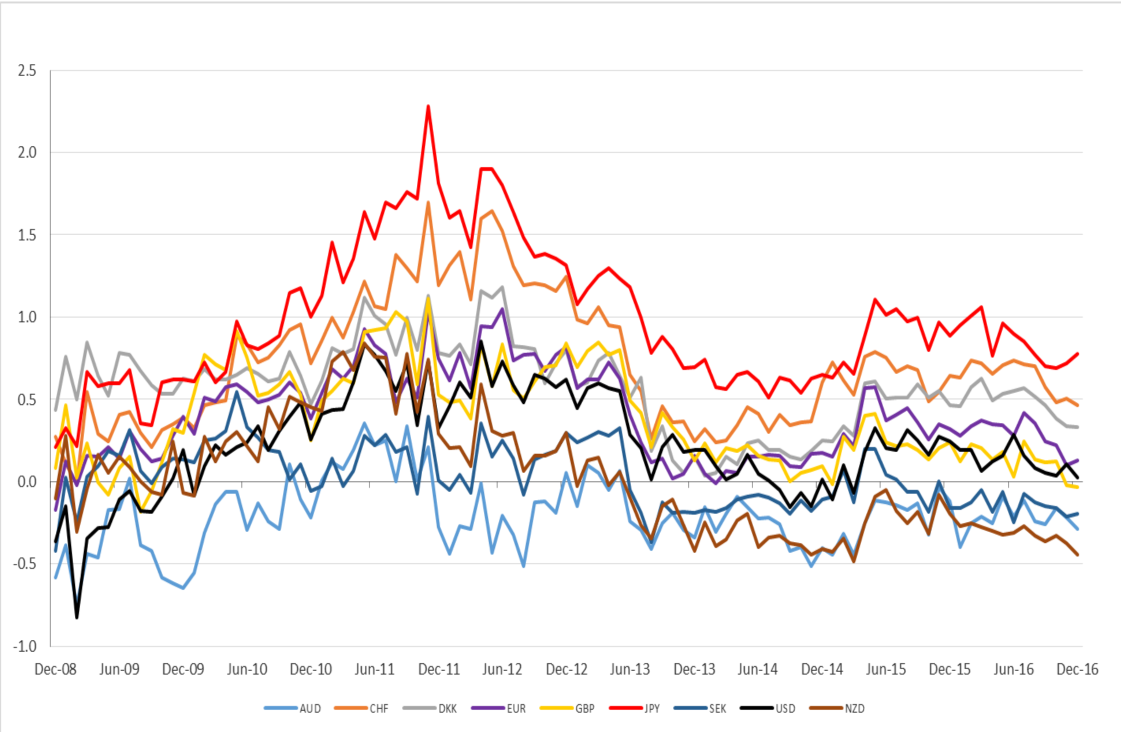
Source: Bloomberg, calculated; units of the y-axis are measured as percent

Figure 17: 5-year Cross-currency Deviations from CIP to the Danish Sovereign Curve



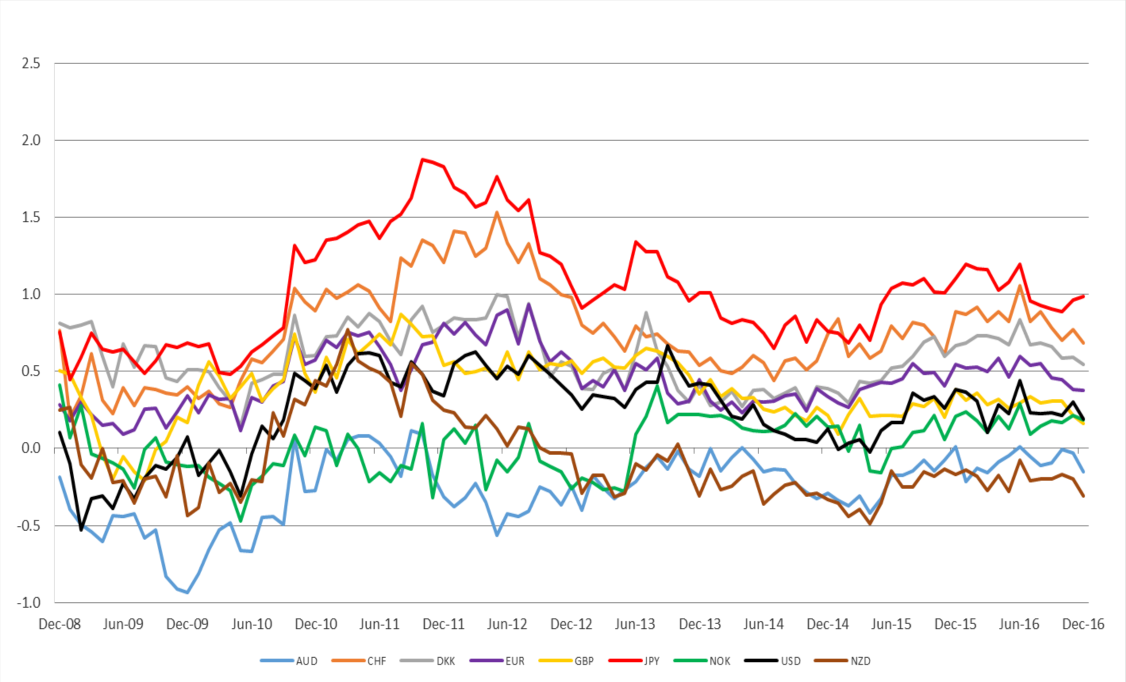
Source: Bloomberg, calculated; units of the y-axis are measured as percent

Figure 18: 5-year Cross-currency Deviations from CIP to the Norway Sovereign Curve



Source: Bloomberg, calculated; units of the y-axis are measured as percent

Figure 19: 5-year Cross-currency Deviations from CIP to the Swedish Sovereign Curve



Source: Bloomberg, calculated; units of the y-axis are measured as percent

On average it is cheap for Dutch and Finnish sovereign-rated issuers to issue in a foreign currency on a covered basis over time. This was also the case for a Danish sovereign-rated issuer, except between October 2013 and April 2014. On the other hand, after March 2009 it was expensive on average for a Norwegian sovereign-rated issuer to issue in a foreign currency. This was also the case for a Swedish sovereign-rated issuer over the full period, bar two months. In detail:

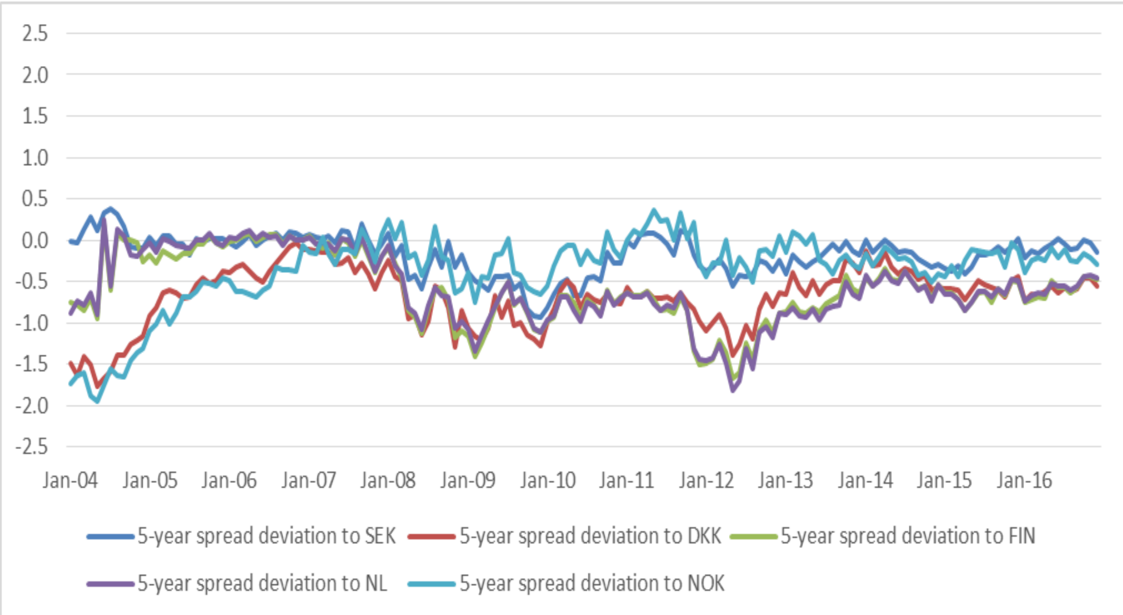
1. For a Dutch sovereign, the AUD, NZD and USD are always cheap to issue in relative to the home currency, while the CHF and JPY are expensive most of the time.
2. For a Finnish sovereign, the AUD, NZD and USD are cheap currencies in which to issue, with the exception of one monthly reading each. CHF and JPY are expensive most of the time.
3. For a Danish sovereign, the AUD and NZD are always cheap to issue in. The JPY is always expensive from October 2009 and the CHF is consistently expensive from May 2010.
4. For a Norwegian sovereign, the AUD and NZD are cheap to issue in at least half of the time. The CHF and JPY are consistently expensive.
5. For a Swedish sovereign, all currencies are expensive to issue in at least half of the time and the CHF and JPY are consistently expensive.

CIP and the cross-currency basis before the Global Financial Crisis

Were CIP to hold, then the cross-currency basis should be close to zero over time and deviations would be difficult to arbitrage after costs. However, a growing literature discusses how the CIP condition has been violated across currency pairs since 2008. For example, Du et al. (2016) also study the 10-day moving average of the three-month Libor cross-currency basis for ten currency pairs with the USD and show that short-term interest rate deviations from CIP were greater after the GFC than before.

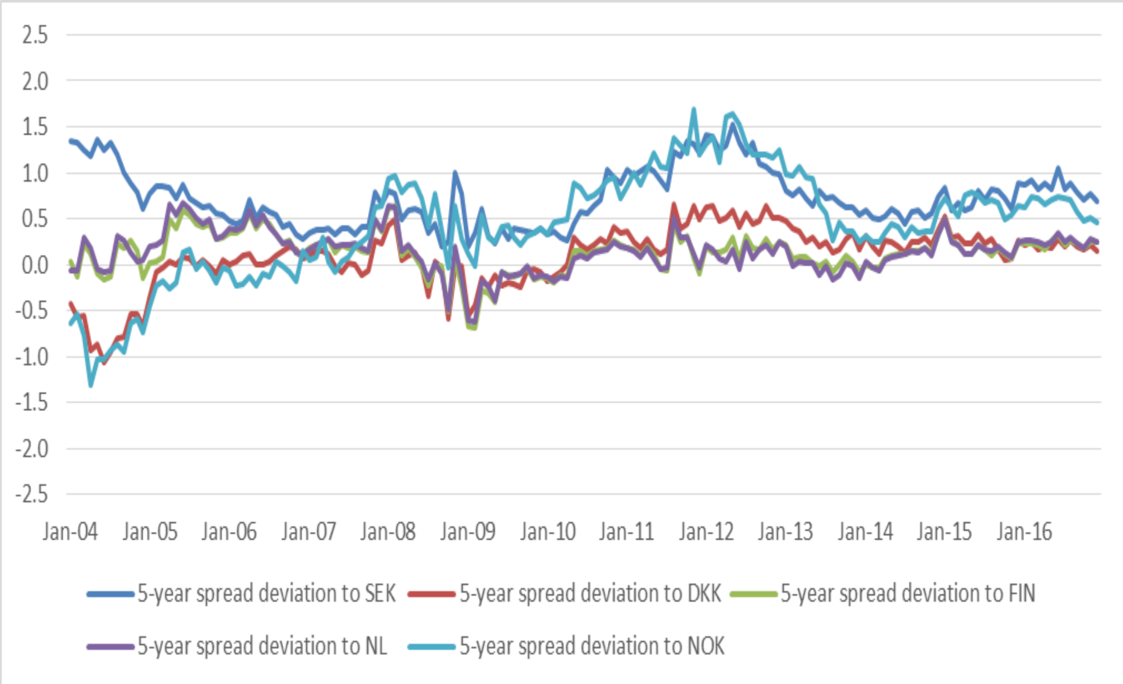
I investigate the behaviour of the longer-term cross-currency basis of AUD, CHF, JPY, NZD and USD against the currencies of the European MBAs. The analysis is extended back to January 2004, which represents a period of 3-4 years before the GFC arose. I calculate the five-year cross-currency swap spread by assuming that a sovereign issues bonds in a given foreign currency and then comparing the resulting implied interest rate that is hedged into their domestic currency with the actual domestic five-year sovereign rate on the same date. A positive spread shows that a currency was expensive for an investor to issue in, relative to the home base. Figures 20 to 24 show the cross-currency deviations from CIP between the currencies of domicile of the six issuing European municipal bond agencies and the five major currencies in which they issued fixed coupon, fixed maturity bonds. This contrasts with Figures 15 to 19, which show results by issuer. Once again, the scales of all Figures are the same, contrasting swap spreads across different issuing currencies.

Figure 20: AUD Cross-currency Deviations from Covered Interest Parity



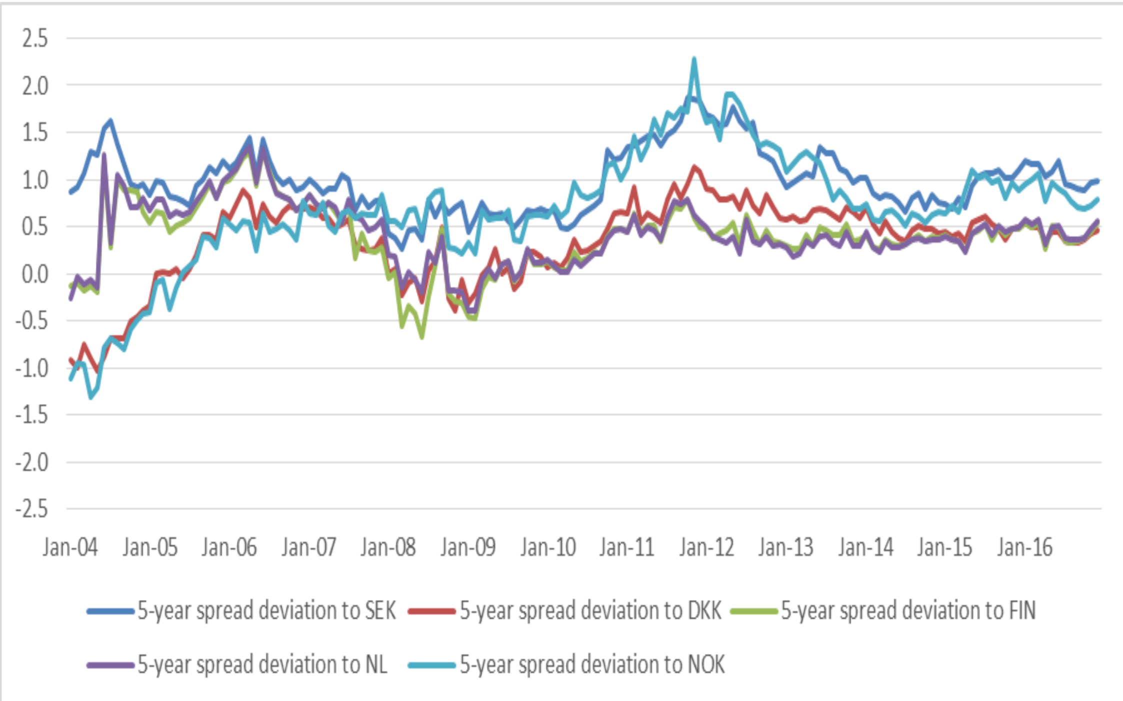
Source: Calculated, Bloomberg; units of the y-axis are measured as percent

Figure 21: CHF Cross-currency Deviations from Covered Interest Parity



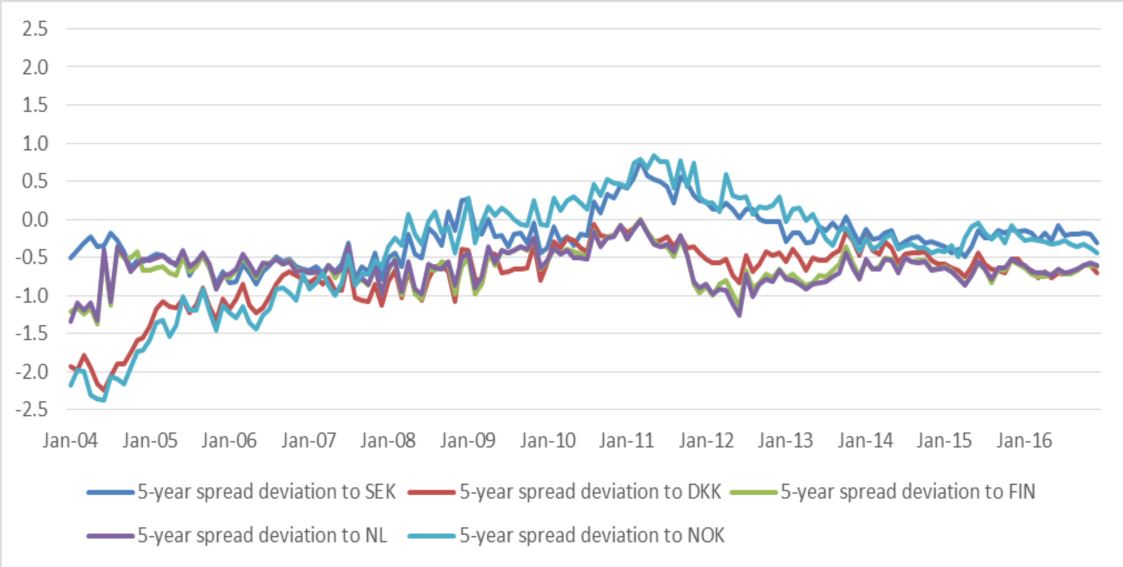
Source: Calculated, Bloomberg; units of the y-axis are measured as percent

Figure 22: JPY Cross-currency Deviations from Covered Interest Parity



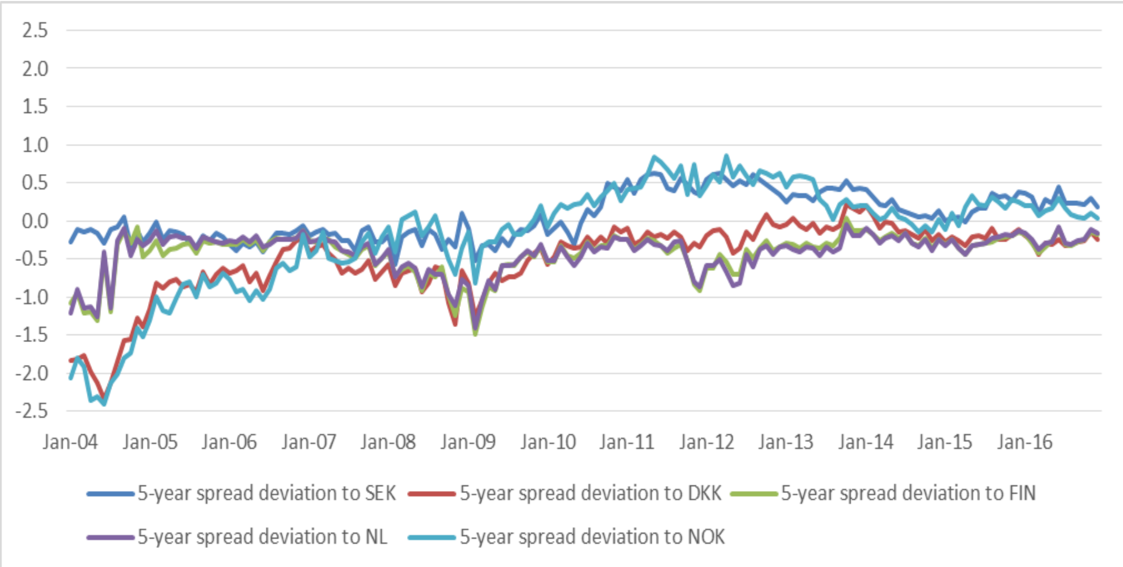
Source: Calculated, Bloomberg; units of the y-axis are measured as percent

Figure 23: NZD Cross-currency Deviations from Covered Interest Parity



Source: Calculated, Bloomberg; units of the y-axis are measured as percent

Figure 24: USD Cross-currency Deviations from Covered Interest Parity



Source: Calculated, Bloomberg; units of the y-axis are measured as percent

Du et al. (2016) show that short-term deviations prior to mid-2007 were always less than 20 basis points for all currency pairs against the USD. CIP was better observed in shorter-dated cross-currency instruments than longer-dated instruments. The results of Figures 20 to 24 are quite different. Over 2004-07 the deviation from zero on a covered basis was at least 20 basis points over time in 21 of the 25 currency pairs presented above. This could provide an issuer with the opportunity to issue a bond favourably in certain foreign currencies relative to issuing in their respective domestic currency. However, even before 2008, CHF and JPY were expensive most of the time as currencies of issuance for Swedish, Finnish and Dutch issuers.

Which MBAs find foreign currency swap spreads favourable?

Table 52 summarises the findings of Figures 15 to 19. It shows the average covered interest cost differentials of foreign currencies relative to all the respective issuers' currencies, sorted by issuer through monthly observations over 2009-16. I calculate the five-year covered difference between the equivalent domestic rate of the foreign currency and the actual domestic rate of the respective issuer (the 'currency spread' or deviation from CIP). It implies that Dutch, Danish and Finnish sovereigns find it cheap to issue on average in the foreign currencies listed on the left hand side of Table 50 relative to their domestic currency. On the other hand, Norwegian and Swedish sovereigns find that foreign currency issuance is on average expensive relative to domestic currency issuance.

Table 52: Which Sovereigns Find It Cheap to Issue in Foreign Currency on Average?

Dutch	Danish	Finnish	Norwegian	Swedish
-0.319	-0.201	-0.311	+0.350	+0.350

Source: Bloomberg, calculated. The units are basis points. A negative figure indicates that the national issuer finds foreign currencies cheap to issue in, relative to its domestic currency on average. A positive figure indicates that foreign currencies are expensive to issue in, relative to domestic currency on average

Table 53 summarises the findings of Figures 20 to 24 and other currencies that are used for bond issuance. It shows the average covered interest cost differentials of foreign currencies relative to issuers' home currencies, sorted by issuing currency and by monthly observations over 2009-16. Across all issuers on a currency hedged basis, the AUD and NZD emerge as currencies that are consistently cheap and the CHF and JPY are consistently expensive. The USD is a cheap currency on average for Dutch, Danish and Finnish sovereign issuers, although it is an expensive currency on average for Norwegian and Swedish sovereigns to issue in on a currency hedged basis.

Table 53: Average Foreign Currency Interest Cost Differential Against Issuers' Domestic Currencies

AUD	CHF	DKK	EUR	GBP	JPY	NOK	NZD	SEK	USD
-0.550	0.372	0.261	0.263	0.040	0.633	-0.400	-0.345	-0.395	-0.116

Source: Bloomberg, calculated. The units are basis points. A negative figure indicates that a currency is cheap to issue in for a sovereign, relative to a domestic currency on average. A positive figure indicates that a currency is expensive to issue in, relative to domestic currency on average

Descriptive analysis of the regression sample

My regression sample includes all 164 bonds that were issued in domestic currency and 472 bonds that were issued over 2009-16 in the five foreign currencies of Table 54. The average spread of the foreign currency to home currency was negative in AUD, NZD and USD and positive in CHF and JPY when an issuer made a decision to issue a bond. MBAs actually issued bonds in one of the five chosen foreign currencies when the 'currency spread' was in their favour 70.3% of the time in the five identified foreign currencies. This compares with my descriptive sample that covers a wider range of currencies on page 140, which claims that 67% of foreign currency bonds are issued more cheaply than their domestic equivalent yield-to-maturity in a wider range of foreign currencies.

Table 54: Relative Value of the 'Currency Spread' for Bonds Issued

	Average spread for 636 bond issues	Number of times issued in foreign currency when 'currency spread' is negative	Number of times issued in domestic currency when 'currency spread' is negative
AUD	-0.618	143/157	160/164
CHF	0.285	35/68	49/164
JPY	0.345	7/9	14/164
NZD	-0.360	59/72	145/164
USD	-0.192	109/166	127/164
Total		353/472	
		70.3%	

Source: Bloomberg, calculated; the 'currency spread' is measured against the domestic currency of the actual bond issuer

Table 55 divides the results of Table 54 into the average spread for bonds that were issued in the issuer's respective domestic currency and the average spread for bonds issued in one of the highlighted foreign currencies on the day of issuance. Average CHF and JPY spreads are marginally negative for foreign currency bonds issued in those currencies and they are positive when issuers used their domestic currency for bond issuance. Average AUD, NZD and USD spreads were negative in both cases. However, they were less negative on average when bonds were issued in each of these currencies than when bonds were issued in an issuer's domestic currency, suggesting a possible lack of timing in the choice between domestic and foreign currency issuance. The AUD and NZD spreads are very often more favourable than the CHF spreads to all issuers, yet the MBAs have issued a total of 68 fixed coupon bonds in CHF over 2009-16.

Comparing the second column of Table 55 when bonds were issued in these currencies, with Table 53's average 'currency spreads' over the full eight years of the study, it is apparent that bonds were issued in CHF and JPY when the respective 'currency spreads' were more advantageous on average to an issuer than their long-term average.

Table 55: Foreign 'Currency Spread' to Domestic Currency for Bonds Issued

	Average spread for foreign currency issues in this currency	Standard Deviation	Average spread at time of domestic issues	Standard Deviation
AUD	-0.596	0.428	-0.679	0.396
CHF	-0.003	0.387	0.219	0.381
JPY	-0.123	0.380	0.327	0.246
NZD	-0.351	0.360	-0.432	0.364
USD	-0.082	0.391	-0.247	0.370

Source: Bloomberg, calculated; the table splits the results of Table 54 into domestic currency bonds and foreign currency bonds issued

Table 56 shows which MBAs observe the relative cheapness of foreign currencies, when issuing foreign currency bonds over 2009-16. The euro is an attractive base currency: BNG and NWB have generated interest cost savings 90.5% and 91.7% of the time respectively by issuing in a foreign currency. The other euro-based issuer, MuniFin, has sourced interest cost savings 94.7% of the time. From a Danish krone base, Kommunekredit has sourced interest cost savings 93.3% of the time.

However, Kommuninvest and KBN find issuing in a foreign currency to be expensive most of the time. Each generates interest cost savings only 42.5% of the time. Their respective success rates in selecting advantageous timing for USD bond issuance are low, unlike the other four MBAs. They also both failed to generate interest cost savings whenever they issued single currency bonds in CHF.

Table 56: Foreign Currency Issues When the 'Currency Spread' Is Negative by Issuer

	AUD	CHF	JPY	NZD	USD	Total
BNG	35/35	8/16	1/3	13/13	38/38	95/105
NWB	14/14	12/17	5/5	1/1	23/23	55/60
MuniFin	34/34	10/15	1/1	22/22	23/23	90/95
Kommuninvest	19/23	0/7	0/0	6/11	6/32	31/73
KBN	25/35	0/6	0/0	8/16	7/37	40/94
Kommunekredit	16/16	5/7	0/0	9/9	12/13	42/45
	143/157	35/68	7/9	59/72	109/166	353/472

Source: Bloomberg, calculated
Key is number of times issued when 'currency spread' is negative / number of times issued

Table 57 shows the development of 'currency spreads' for issued bonds over time. Interest cost savings from issuing in a foreign currency were generated a little more than half of the time during 2011-12. Following this period, issuance after 2013 was largely focused on three currencies – AUD, NZD and USD.

Figures 21 and 22 show that CHF and JPY were relatively attractive currencies for Dutch, Finnish and Danish issuers in 2009, which reflects in activity in these currencies in that year. However, each of the six MBAs issued bonds at least once in CHF after 2010 and a total of 18 such bonds were issued. On only one occasion was the CHF spread favourable after April 2010, which raises the question of why MBAs are issuing in the CHF at all, when Swiss 'currency spreads' are often unfavourable relative to the domestic currency and other available foreign currencies. However, with CHF covered interest costs to bond issuers relatively high 49% of the time over the full period (refer to Figure 21), bond issuance by all agencies has dwindled in this currency since 2010.

Table 57: Foreign Currency Issues When the 'Currency Spread' Is Negative by Year

	AUD	CHF	JPY	NZD	USD	Total
2009	16/16	19/28	3/5	19/21	11/11	68/81
2010	32/32	15/22	2/2	5/8	18/25	72/89
2011	18/30	0/7	0/0	6/9	14/25	38/71
2012	24/24	0/6	0/0	6/9	8/21	38/60
2013	21/23	0/2	0/0	5/7	9/17	35/49
2014	21/21	1/2	2/2	11/11	17/24	52/60
2015	6/6	0/1	0/0	4/4	16/20	26/31
2016	5/5	0/0	0/0	3/3	16/23	24/31
	143/157	35/68	7/9	59/72	109/166	353/472

Source: Calculated; Key is number of times issued when 'currency spread' is negative/number of times issued

REGRESSION MODELS

I model the MBA's decision to issue a bond in a given foreign currency, based on the covered interest cost differential of the foreign currency relative to the issuer's owncurrency and other variables. This decision can be modelled as a joint decision to issue a bond and choose a foreign currency or as a decision to issue in a foreign currency, conditional upon the decision to issue a bond. I present regression results for both outputs. They are related as follows:

I is the agency's decision whether or not to invest:

$I = 1$, if the agency decides to issue a bond

$= 0$, if the agency decides not to issue a bond

C is the agency's decision to issue in a given foreign currency:

$C = 1$, if the agency issues in a given foreign currency

$= 0$, otherwise

For each foreign currency:

$$E\,[C.I] = E\,[C.I \mid I = 1]\ x\ Prob\ (I = 1) + E\,[C.I \mid I = 0]\ x\ Prob\ (I = 0)$$

$$= E\,[C \mid I = 1]\ x\ Prob\ (I = 1)$$

To investigate the effect of currency swap spreads on the MBA's choice of foreign currency, I undertake probit regressions of the decision to issue in that currency. Following Black and Munro (2010) and Mizen et al. (2012), the probit regression estimates the probability that an agency will issue a bond in a given month. The regression takes the form:

$$Prob\ (BOND_{ijt} = 1) = \alpha_i + X_{ijt}\ \beta_i + Z_{ijt}\ \gamma_i + \epsilon_{ijt}\ ;\ \epsilon_{ijt}\ \sim IID\ (0, \sigma_\epsilon^2)$$

$BOND_{ijt}$, is a dummy variable that equals 1 if agency i issues a bond in foreign currency j in month t and equals zero otherwise.

X_{ijt} represents the covered interest cost differential of a foreign currency relative to the domestic currency of the issuer. I compare the domestic currency equivalent of the five-year foreign sovereign zero-coupon yield with the duration matched actual domestic currency sovereign yield. This defines a 'currency spread' or deviation from CIP relative to the domestic currencies of the respective issuers.

Z_{ijt} represents control variables that may include foreign market depth (size of available markets, liquidity and foreign investor base), bank credit default spreads (a proxy for counterparty risk) and benchmark bond redemption dummies (in the US).

The signs of the β coefficients reveal the sensitivity of the issue decision to deviations from CIP. A negative deviation for an issuer implies that the target foreign currency is attractive relative to its domestic currency. For univariate regressions, I expect the β coefficients to be negative, if a 'currency spread' affects the decision to issue in a given foreign currency. For multivariable regressions, I expect the β coefficients to be negative when the 'currency spread' is that of the currency of bond issuance and positive when the 'currency spread' is of a different currency from the currency of bond issuance.

Univariate probit models study the decision of each agency to issue a bond in a particular currency (1 = issue, 0 = do not issue). This analysis is undertaken:
(i) for the joint decision to issue a bond and choose a particular foreign currency and (ii) for the conditional foreign currency decision, given that an issuer has decided to issue a bond. Results for the joint decision cases are shown from Tables 59 to 82.
By comparison, in Tables 126 to 131 in the Appendix, I investigate the agencies' decision to choose a foreign currency, conditional on first making a decision to issue a bond. Probit estimations of the conditional decision produce similar results.

I extend the regressions to multivariable probit models, which introduce a vector of currency swap spreads of all relevant currency pairs. This analysis is undertaken both (i) for the joint decision to issue a bond and choose a particular foreign currency and (ii) for the foreign currency decision, given that an issuer has decided to issue a bond. Results for the joint decision cases are included in Tables 83 to 106. The results for the conditional cases, once the decision to issue a bond has been made, are included in Tables 132 to 137 in the Appendix.

A pooled multinomial model highlights the choice of five foreign currencies relative to the base domestic currency of respective issuers. This is summarised in Table 108. Marginal effects highlight the elasticity of the choice decision as a function of the currency swap spread and other control variables. I look at six currencies for the choice of currency of issuance (including the issuer's home currency) of fixed term, fixed coupon bonds. I include every fixed coupon, fixed maturity-date bond, issued by the six MBAs between January 2009 and December 2016. These represent 636 bonds. I am interested in five currency pairs against the domestic currencies of the six agencies.

Individual agencies results: joint decision univariate probit regressions

Initially, I look at univariate probit regressions on currency choice for a bond issue. From Tables 59 to 82, I look at the joint decision of an agency both to issue a bond and in which foreign currency to issue. I am interested in five currency pairs against the domestic currencies of the six agencies and present four tables for each MBA bond issuer:

1. a probit regression that includes every bond that is issued;
2. the average marginal effects of the above regression;
3. a probit regression that includes every bond that is issued, even if more than one bond is issued in any month, with month fixed effects that eliminate seasonal factors;
4. a linear regression that includes every bond that is issued, even if there is more than one bond issued in any one month;

There are relatively few months when an agency issues more than one bond in a particular currency. As an example, the issuer of the largest number of foreign currency bonds, BNG, issued fixed coupon bonds in 33 of the 96 months reviewed in AUD, in 13 months in CHF and in 37 months in USD. In total, BNG issued 35 fixed coupon bonds in AUD, 16 bonds in CHF and 38 fixed coupon bonds in USD.

Table 58: Number of Foreign Currency Bonds Issued: January 2009 - December 2016

Issuer	AUD	CHF	JPY	NZD	USD
BNG	35	16	3	13	38
NWB	14	17	5	1	23
KBN	35	6	0	16	37
Kommunekredit	16	7	0	9	13
Kommuninvest	23	7	0	11	32
MuniFin	34	15	1	22	23
Total	157	68	9	72	166

Source: Bloomberg

The dependent variable for a given currency in the regressions is one for every bond that is issued and zero in a month of no bond issue. Observations are over 96 discrete months. A univariate analysis restricts the agency to looking at the 'currency spread' (i.e. the deviation from CIP) between its domestic currency and the respective foreign currency of issue. It is comparing one foreign currency only to its domestic currency. In a month when a bond is issued in a foreign currency, I calculate the 'currency spread' on the curve date for the respective bond issue. If there is a month with no issue, I calculate the 'currency spread' as the average of the month-start and month-end values. The more negative a covered 'currency spread' is, the more attractive that currency is to issue in, relative to the issuer's domestic currency. Thus, I look for a negative and significant regression coefficient to indicate that an issuer's decision to issue in that foreign currency is sensitive to that spread. Likewise, I look for the marginal effects coefficients to be negative.

The power of the probit and linear regressions is not strong – McFadden R-squareds are low in general and the majority of regressors across the base probit regressions are not significant. The McFadden R-squareds of regressions with month fixed effects are higher than those of the base probit regressions. Regressions with fixed effects and linear regressions serve to confirm the findings of the base probit regressions, in general. Comments below refer to the base probit regressions:

The strongest signal is for the CHF: for four of the MBAs, the regression coefficient on the CHF 'currency spread' is negative and significant. The exceptions are KBN and Kommuninvest.

Both Dutch issuers generate a significant and negative coefficient on deciding on bond issues in AUD, according to respective 'currency spreads'. In the case of KBN, the AUD coefficient is significant, but counter-intuitively positive.

The NZD coefficient is not significant for any MBA. NZD 'currency spreads' are nearly always in favour (i.e. negative) for European issuers, so it seems that agencies are not timing bond issues in this currency.

The USD coefficient is significant only for Kommuninvest, where it is counter-intuitively positive. The lack of significance of USD regressors might suggest a different motivation for timing bond issuance in the agencies' most important foreign currency.

The regression coefficient on the JPY 'currency spread' is negative and significant only for the Dutch issuers. JPY regressions do not generate results for the four other issuers, which have made very few JPY bond issues.

Of the agencies, NWB generates negative and significant regressors in four of its base probit regressions. However, two of these are for currencies in which it made relatively few bond issues. BNG generates negative and significant regressors in three of its base probit regressions.

I repeat the above analysis, by including just the first bond issued in a month of multiple bond issues (results not reported). This generates similar results to those included below:

Table 59: Probit of BNG's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	JPY	NZD	USD
constant	-0.960 ** (0.381)	-0.894 *** (0.160)	-1.243 *** (0.326)	-0.874 * (0.453)	-0.078 (0.278)
AUD spread	-0.723 * (0.432)				
CHF spread		-2.322 *** (0.861)			
JPY spread			-3.082 ** (1.205)		
NZD spread				0.395 (0.722)	
USD spread					0.506 (0.637)
McFadden R-squared	0.021	0.091	0.273	0.004	0.005
Number of observations = 1	35	16	3	13	38
Number of observations = 0	63	83	93	84	59

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period is January 2009 to December 2016. The McFadden R-squared measures the improvement of the regression fit against a regression on a constant only. I use this definition in all relevant tables in Chapter 3

Table 60: Marginal Effects of BNG's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	JPY	NZD	USD
AUD spread	-0.264 * (0.151)				
CHF spread		-0.516 *** (0.159)			
JPY spread			-0.164 ** (0.080)		
NZD spread				0.085 (0.173)	
USD spread					0.193 (0.248)
Number of observations	98	99	96	97	97

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 61: Probit of BNG Joint Issue Decision in a Given Currency - Month Fixed Effects

Estimator	AUD	CHF	JPY	NZD	USD
constant	-1.789 ** (0.722)	-0140 (0.460)	0.455 *** (0.730)	-0.359 (0.664)	0.303 (0.506)
AUD spread	-0.766 * (0.448)				
CHF spread		-2.951 *** (0.778)			
JPY spread			-4.887 *** (1.899)		
NZD spread				0.587 (0.927)	
USD spread					0.988 (0.740)
McFadden R-squared	0.169	0.161	0.458	0.123	0.185
Number of observations = 1	35	16	3	13	38
Number of observations = 0	55	43	13	52	43

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 62: Linear Regression of BNG's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	JPY	NZD	USD
constant	0.135 (0.137)	0.206 *** (0.043)	0.126 * (0.071)	0.189 (0.121)	0.466 *** (0.107)
AUD spread	-0.273 * (0.160)				
CHF spread		-0.615 *** (0.212)			
JPY spread			-0.288 (0.177)		
NZD spread				0.091 (0.187)	
USD spread					0.189 (0.238)
R-squared	0.028	0.090	0.108	0.003	0.007
Number of observations = 1	35	16	3	13	38
Number of observations = 0	63	83	93	84	59

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 63: Probit of NWB's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	JPY	NZD	USD
constant	-1.890 *** (0.471)	-0.946 *** (0.171)	-0.985 *** (0.332)	-6.655 *** (1.807)	-0.377 (0.272)
AUD spread	-0.974 * (0.511)				
CHF spread		-4.144 *** (0.988)			
JPY spread			-3.051 *** (0.993)		
NZD spread				-5.326 ** (2.299)	
USD spread					0.900 (0.606)
McFadden R-squared	0.044	0.249	0.224	0.351	0.014
Number of observations = 1	14	17	5	1	23
Number of observations = 0	83	84	92	95	74

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 64: Marginal Effects of NWB's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	JPY	NZD	USD
AUD spread	-0.212 * (0.109)				
CHF spread		-0.775 *** (0.150)			
JPY spread			-0.243 ** (0.109)		
NZD spread				-0.098 (0.096)	
USD spread					0.274 (0.184)
Number of observations	97	101	97	96	97

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 65: Probit of NWB Joint Issue Decision in a Given Currency – Month Fixed Effects

Estimator	AUD	CHF	JPY	NZD	USD
constant	-2.145 *** (0.716)	-0.279 (0.549)	0.435 (0.649)	n/a -	-0.121 (0.528)
AUD spread	-1.118 ** (0.539)				
CHF spread		-4.819 *** (1.238)			
JPY spread			-7.269 *** (2.441)		
NZD spread				n/a -	
USD spread					1.740 ** (0.720)
McFadden R-squared	0.092	0.365	0.501	-	0.138
Number of observations = 1	14	17	5	-	23
Number of observations = 0	67	36	20	-	58

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 66: Linear Regression of NWB's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	JPY	NZD	USD
constant	-0.054 (0.110)	0.227 *** (0.040)	0.165 ** (0.073)	-0.040 (0.039)	0.327 *** (0.079)
AUD spread	-0.245 * (0.143)				
CHF spread		-0.982 *** (0.193)			
JPY spread			-0.351 ** (0.167)		
NZD spread				-0.084 (0.082)	
USD spread					0.229 (0.139)
R-squared	0.039	0.236	0.102	0.032	0.013
Number of observations = 1	14	17	5	1	23
Number of observations = 0	83	84	92	95	74

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 67: Probit of MuniFin's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	-0.614 (0.377)	-1.005 *** (0.175)	-0.362 (0.393)	-0.747 *** (0.289)
AUD spread	-0.185 (0.440)			
CHF spread		-3.300 *** (0.777)		
NZD spread			0.685 (0.632)	
USD spread				-0.081 (0.651)
McFadden R-squared	0.001	0.255	0.010	0.000
Number of observations = 1	34	15	22	23
Number of observations = 0	72	85	76	74

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 68: Marginal Effects of MuniFin's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
AUD spread	-0.066 (0.157)			
CHF spread		-0.581 *** (0.100)		
NZD spread			0.203 (0.186)	
USD spread				-0.025 (0.201)
Number of observations	106	100	98	97

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 69: Probit of MuniFin's Joint Issue Decision in a Given Currency – Month Fixed Effects

Estimator	AUD	CHF	NZD	USD
constant	-0.147 (0.581)	-0.850 *** (0.622)	-0.743 (0.692)	-1.212 ** (0.529)
AUD spread	-0.182 (0.467)			
CHF spread		-3.034 *** (0.831)		
NZD spread			0.695 (0.764)	
USD spread				-0.151 (0.778)
McFadden R-squared	0.113	0.339	0.050	0.125
Number of observations = 1	34	15	22	23
Number of observations = 0	56	25	52	58

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 70: Linear Regression of MuniFin's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	0.267 * (0.136)	0.206 *** (0.035)	0.341 *** (0.125)	0.227 ** (0.092)
AUD spread	-0.067 (0.161)			
CHF spread		-0.883 *** (0.162)		
NZD spread			0.198 (0.187)	
USD spread				-0.026 (0.211)
R-squared	0.002	0.270	0.001	0.000
Number of observations = 1	34	15	22	23
Number of observations = 0	72	85	76	74

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 71: Probit of Kommuninvest's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	-0.832 ***	-0.958	-1.177 ***	-0.664 ***
	(0.226)	(0.633)	(0.171)	(0.190)
AUD spread	-0.372			
	(0.641)			
CHF spread		-0.688		
		(0.886)		
NZD spread			0.733	
			(0.611)	
USD spread				0.821
				(0.538)
McFadden R-squared	0.004	0.024	0.022	0.020
Number of observations = 1	23	7	11	32
Number of observations = 0	76	89	85	68

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 72: Marginal Effects of Kommuninvest's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
AUD spread	-0.094			
	(0.119)			
CHF spread		-0.581 ***		
		(0.100)		
NZD spread			-0.139	
			(0.115)	
USD spread				0.288
				(0.181)
Number of observations	99	96	96	100

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 73: Probit of Kommuninvest's Joint Issue Decision in a Given Currency – Month Fixed Effects

Estimator	AUD	CHF	NZD	USD
constant	-0.456	-0.442	-1.194 **	-1.076 **
	(0.501)	(0.907)	(0.541)	(0.493)
AUD spread	-0.642			
	(0.737)			
CHF spread		-0.937		
		(0.899)		
NZD spread			0.956	
			(0.586)	
USD spread				1.238 **
				(0.619)
McFadden R-squared	0.118	0.057	0.085	0.192
Number of observations = 1	23	7	11	32
Number of observations = 0	44	41	53	60

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 74: Linear Regression of Kommuninvest's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	0.200 ***	0.151	0.125 ***	0.255 ***
	(0.069)	(0.102)	(0.036)	(0.058)
AUD spread	-0.122			
	(0.214)			
CHF spread		-0.102		
		(0.120)		
NZD spread			0.158	
			(0.146)	
USD spread				0.285
				(0.177)
R-squared	0.004	0.014	0.017	0.025
Number of observations = 1	23	7	11	32
Number of observations = 0	76	89	85	68

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 75: Probit of KBN's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	-0.185	-0.502	-0.974 ***	-0.452 ***
	(0.171)	(0.601)	(0.153)	(0.171)
AUD spread	1.342 **			
	(0.685)			
CHF spread		-1.867		
		(1.258)		
NZD spread			-0.325	
			(0.416)	
USD spread				0.526
				(0.446)
McFadden R-squared	0.033	0.140	0.006	0.011
Number of observations = 1	35	6	16	37
Number of observations = 0	70	92	81	62

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 76: Marginal Effects of KBN's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
AUD spread	0.471 **			
	(0.224)			
CHF spread		-0.200		
		(0.129)		
NZD spread			-0.080	
			(0.103)	
USD spread				0.288
				(0.181)
Number of observations	105	98	97	99

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 77: Probit of KBN Joint Issue Decision in a Given Currency - Month Fixed Effects

Estimator	AUD	CHF	NZD	USD
constant	-0.383	0.621	-1.178 **	-1.337 **
	(0.519)	(0.768)	(0.566)	(0.578)
AUD spread	1.553 **			
	(0.771)			
CHF spread		-2.049 *		
		(1.124)		
NZD spread			-0.520	
			(0.487)	
USD spread				0.649
				(0.476)
McFadden R-squared	0.120	0.207	0.065	0.092
Number of observations = 1	35	6	16	37
Number of observations = 0	46	28	49	46

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 78: Linear Regression of KBN's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	0.427 ***	0.167 **	0.166 ***	-0.452 ***
	(0.065)	(0.071)	(0.038)	(0.171)
AUD spread	0.489 **			
	(0.233)			
CHF spread		-0.148 **		
		(0.073)		
NZD spread			-0.074	
			(0.093)	
USD spread				0.526
				(0.441)
R-squared	0.043	0.052	0.005	0.011
Number of observations = 1	35	6	16	37
Number of observations = 0	70	92	81	62

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 79: Probit of Kommunekredit's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	-0.664	-1.135 ***	-1.530 ***	-0.802 ***
	(0.445)	(0.222)	(0.506)	(0.219)
AUD spread	0.470			
	(0.628)			
CHF spread		-3.006 ***		
		(0.927)		
NZD spread			-0.426	
			(0.946)	
USD spread				1.377 **
				(0.640)
McFadden R-squared	0.007	0.268	0.003	0.034
Number of observations = 1	16	7	9	13
Number of observations = 0	82	89	87	83

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 80: Marginal Effects of Kommunekredit's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
AUD spread	0.115 **			
	(0.153)			
CHF spread		-0.314 ***		
		(0.090)		
NZD spread			-0.071	
			(0.158)	
USD spread				0.289
				(0.144)
Number of observations	98	96	96	96

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 81: Probit of Kommunekredit's Joint Issue Decision in a Given Currency - Month Fixed Effects

Estimator	AUD	CHF	NZD	USD
constant	-0.135	-0.807 *	-1.559 **	-0.701
	(0.624)	(0.488)	(0.787)	(0.619)
AUD spread	0.449			
	(0.677)			
CHF spread		-3.348 ***		
		(0.940)		
NZD spread			-0.865	
			(1.030)	
USD spread				2.325 ***
				(0.879)
McFadden R-squared	0.097	0.340	0.034	0.201
Number of observations = 1	16	7	9	13
Number of observations = 0	58	33	47	43

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 82: Linear Regression of Kommunekredit's Joint Issue Decision in a Given Currency

Estimator	AUD	CHF	NZD	USD
constant	0.241 **	0.176 ***	0.061	0.189 ***
	(0.113)	(0.056)	(0.074)	(0.052)
AUD spread	0.112			
	(0.148)			
CHF spread		-0.469 ***		
		(0.168)		
NZD spread			-0.067	
			(0.093)	
USD spread				0.209 **
				(0.091)
R-squared	0.006	0.173	0.002	0.021
Number of observations = 1	16	7	9	13
Number of observations = 0	82	89	87	83

Source: Calculated; robust standard errors; key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Individual agencies results: joint decision multivariable probit regressions

From Tables 83 to 106, I investigate the MBA's joint decision to issue a bond and issue in a particular foreign currency, according to five different 'currency spread' regressors. The dependent variable is one for every bond that is issued and zero in a month of no bond issue in a given currency. If 'currency spread' is to predict a bond issue in a particular currency, I expect the regressors' coefficients to be negative when the 'currency spread' is that of the currency of bond issuance and positive when the 'currency spread' is of a different currency from the currency of bond issuance. I also include marginal effects of the base probit regressions, probit regressions with month fixed effects and linear regressions of the MBA's decision. Some of the probit models with month fixed effects fail to converge. Columns where there are insufficient data or no activity in a particular currency choice are omitted. The McFadden R-squareds of regressions with fixed effects are higher in general than those of the base probit regressions.

BNG shows evidence of a relationship between the 'currency spreads' and the decision to issue in AUD: here the AUD regressor is negative and significant and the NZD and USD spread coefficients are positive and significant. However, for BNG's decision to issue in other currencies, the regressor on the leading diagonal (e.g. CHF spread for CHF choice, etc.) is not significant and few other regressors are significant. Kommunekredit generates a significant and negative AUD spread coefficient for the decision to issue in AUD and a significant and negative CHF spread coefficient for the decision to issue in CHF, but there are few other significant regressors. Other MBA results are not compelling: Kommuninvest even generates a positive and significant NZD spread regressor for the decision to issue in NZD. Interestingly, not one regression model returns a negative and significant regressor for the decision to issue a bond in USD. Linear regression models provide comparison with the non-linear models. Even here, there are few significant regressors.

The above results raise questions, such as whether the small number of significant regressors is a factor of a relatively low number of positive monthly decision outcomes or whether the MBAs are not focusing on the relative value of foreign currencies for timing of bond issuance, especially given that AUD and NZD (two of the most popular currencies) are cheap relative to their respective home currencies for most of the time.

Table 83: Probit of BNG's Joint Decision

Estimator	AUD	CHF	JPY	NZD	USD
constant	0.362	1.467	-2.520 **	-0.906	-0.742
	(0.608)	(1.055)	(1.064)	(0.656)	(0.566)
AUD spread	-2.615 ***	-2.160 *	7.426	-0.621	1.042
	(0.920)	(1.211)	(5.530)	(0.986)	(0.816)
CHF spread	-1.259	2.417	-2.242	3.232 **	2.730 **
	(1.529)	(1.791)	(3.612)	(1.559)	(1.360)
JPY spread	-1.802	-7.262 ***	1.968	-1.969	-1.751
	(1.297)	(1.984)	(2.801)	(1.241)	(1.154)
NZD spread	1.804 **	2.204 **	-3.714	1.133	0.392
	(0.772)	(1.004)	(4.190)	(0.838)	(0.689)
USD spread	2.852 **	2.945 *	-6.821 **	-0.746	-1.026
	(1.288)	(1.640)	(2.959)	(1.381)	(1.270)
McFadden R-squared	0.132	0.362	0.484	0.056	0.061
Number of observations	98	99	96	97	97
Number of observations = 1	35	16	3	13	38

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 84: BNG's Joint Decision – Marginal Effects

Estimator	AUD	CHF	JPY	NZD	USD
AUD spread	0.840 ***	-0.335 *	0.265	-0.126	0.374
	(0.251)	(0.190)	(0.233)	(0.201)	(0.286)
CHF spread	-0.405	0.375	-0.080	0.657 *	0.980 **
	(0.485)	(0.265)	(0.133)	(0.328)	(0.456)
JPY spread	-0.579	-1.127 ***	0.070	-0.400	-0.628
	(0.406)	(0.245)	(0.110)	(0.261)	(0.401)
NZD spread	0.580 ***	0.342 **	-0.133	0.230	0.141
	(0.222)	(0.149)	(0.149)	(0.175)	(0.246)
USD spread	0.916 **	0.457 *	-0.244	-0.152	-0.368
	(0.380)	(0.250)	(0.160)	(0.281)	(0.451)
Number of observations	98	99	96	97	97

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 85: Probit of BNG's Joint Decision with Month Fixed Effects

Estimator	AUD	CHF	JPY	NZD	USD
constant	-0.558	2.631 **	-	-0.437	1.631 **
	(1.068)	(1.239)	-	(0.946)	(0.751)
AUD spread	-3.836 ***	-4.575 ***	-	-0.971	2.671 ***
	(1.083)	(1.684)	-	(1.205)	(1.018)
CHF spread	-1.256	2.104	-	2.966 **	4.148 **
	(1.814)	(1.887)	-	(1.378)	(1.763)
JPY spread	-2.845 *	-10.568 ***	-	-1.700	-2.029
	(1.565)	(2.566)	-	(1.420)	(1.333)
NZD spread	2.764 ***	3.521 ***	-	1.606	0.529
	(0.871)	(1.342)	-	(1.008)	(0.785)
USD spread	4.690 ***	6.640 ***	-	-0.403	-2.311
	(1.576)	(2.309)	-	(1.729)	(1.517)
McFadden R-squared	0.335	0.511	-	0.170	0.289
Number of observations	90	59	-	65	81
Number of observations = 1	35	16	-	13	38

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 86: Linear Regression of BNG's Joint Decision

Estimator	AUD	CHF	JPY	NZD	USD
constant	0.627 ***	0.659 ***	-0.001	0.191	0.743 ***
	(0.206)	(0.155)	(0.054)	(0.150)	(0.189)
AUD spread	-0.910 ***	-0.424 *	0.274 **	-0.125	0.366
	(0.305)	(0.244)	(0.135)	(0.235)	(0.297)
CHF spread	-0.391	0.405	-0.112	0.583 *	1.003 **
	(0.517)	(0.281)	(0.122)	(0.340)	(0.461)
JPY spread	-0.622	-1.212 ***	0.034	-0.368	-0.621
	(0.411)	(0.268)	(0.085)	(0.291)	(0.414)
NZD spread	0.651 **	0.560 ***	-0.093 *	0.201	0.131
	(0.273)	(0.197)	(0.061)	(0.200)	(0.261)
USD spread	0.961 **	0.369	-0.491	-0.097	-0.382
	(0.412)	(0.342)	(0.054)	(0.278)	(0.464)
R-squared	0.165	0.362	0.235	0.039	0.077
Number of observations	98	99	96	97	97
Number of observations = 1	35	16	3	13	38

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 87: Probit of NWB's Joint Decision

Estimator	AUD	CHF	JPY	USD
constant	-3.552 ***	-1.741 **	18.406 **	-0.199
	(0.863)	(0.809)	(8.997)	(0.635)
AUD spread	-0.887	-4.160 ***	20.056 **	0.236
	(1.381)	(1.331)	(9.600)	(0.886)
CHF spread	-1.174	-2.540	-29.769	2.363
	(2.024)	(2.156)	(18.574)	(1.425)
JPY spread	0.011	-2.391	-4.326	-1.481
	(1.891)	(1.697)	(5.280)	(1.248)
NZD spread	-4.641 ***	2.695 ***	12.522 *	-0.085
	(1.453)	(0.972)	(6.916)	(0.750)
USD spread	3.599 *	1.910	5.916	0.264
	(1.997)	(1.768)	(5.831)	(1.279)
McFadden R-squared	0.234	0.421	0.627	0.038
Number of observations	97	101	97	97
Number of observations = 1	14	17	5	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 88: NWB's Joint Decision – Marginal Effects

Estimator	AUD	CHF	JPY	USD
AUD spread	-0.156	-0.597 ***	0.835 ***	0.070
	(0.240)	(0.185)	(0.286)	(0.261)
CHF spread	-0.206	-0.364	-1.239 **	0.701 *
	(0.350)	(0.296)	(0.584)	(0.412)
JPY spread	0.002	-0.343	-0.180	-0.439
	(0.333)	(0.233)	(0.228)	(0.367)
NZD spread	-0.816 ***	0.387 **	0.521 **	-0.025
	(0.263)	(0.160)	(0.207)	(0.222)
USD spread	0.633 *	0.274	0.246	0.078
	(0.350)	(0.241)	(0.219)	(0.381)
Number of observations	97	101	97	97

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 89: Probit of NWB's Joint Decision with Month Fixed Effects

Estimator	AUD	CHF	JPY	USD
constant	-4.483 ***	-	-	0.216
	(1.226)	-	-	(0.853)
AUD spread	-0.499	-	-	-0.558
	(1.554)	-	-	(1.099)
CHF spread	-1.129	-	-	2.930 *
	(1.877)	-	-	(1.604)
JPY spread	-0.870	-	-	-2.042
	(2.123)	-	-	(1.602)
NZD spread	-6.954 ***	-	-	0.484
	(2.471)	-	-	(0.879)
USD spread	3.913	-	-	1.969
	(2.391)	-	-	(1.735)
McFadden R-squared	0.322	-	-	0.166
Number of observations	81	53	25	81
Number of observations = 1	14	17	5	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 90: Linear Regression of NWB's Joint Decision

Estimator	AUD	CHF	JPY	NZD	USD
constant	-0.203	0.219	0.175 *	-0.073	0.380 **
	(0.131)	(0.181)	(0.989)	(0.072)	(0.176)
AUD spread	-0.299	-0.545 **	0.289 *	-0.106	0.125
	(0.207)	(0.247)	(0.147)	(0.104)	(0.273)
CHF spread	0488	-0.225	-0.257	0.013 *	0.697 **
	(1.413)	(0.261)	(0.169)	(0.023)	(0.423)
JPY spread	0.087	-0.642 **	-0.021	0.003	-0.415
	(0.311)	(0.283)	(0.170)	(0.025)	(0.345)
NZD spread	-0.520 ***	0.348 **	0.007	-0.025	-0.055
	(0.143)	(0.168)	(0.073)	(0.026)	(0.224)
USD spread	0.540 **	0.191	-0.348	0.052	-0.018
	(0.244)	(0.381)	(0.253)	(0.056)	(0.354)
R-squared	0.160	0.362	0.181	0.073	0.040
Number of observations	97	101	97	96	97
Number of observations = 1	14	17	5	1	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 91: Probit of MuniFin's Joint Decision

Estimator	AUD	CHF	NZD	USD
constant	-0.484	-1.066	-0.597	-0.751
	(0.488)	(0.775)	(0.578)	(0.597)
AUD spread	0.318	-1.909	2.347 **	0.720
	(0.968)	(1.224)	(0.974)	(0.833)
CHF spread	-2.876 *	-0.446	0.532	0.950
	(1.461)	(1.941)	(1.507)	(1.478)
JPY spread	3.137 ***	-1.915	0.957	0.189
	(0.912)	(1.563)	(1.148)	(1.183)
NZD spread	2.449 ***	2.267 **	0.297	0.118
	(0.666)	(1.127)	(0.758)	(0.837)
USD spread	-1.787	-0.252	-3.758 *	-1.367
	(1.283)	(1.450)	(1.372)	(1.270)
McFadden R-squared	0.215	0.348	0.100	0.012
Number of observations	106	100	98	97
Number of observations = 1	34	15	22	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 92: MuniFin's Joint Decision – Marginal Effects

Estimator	AUD	CHF	NZD	USD
AUD spread	0.088	-0.292 *	0.637 ***	0.219
	(0.266)	(0.177)	(0.241)	(0.252)
CHF spread	-0.792 **	-0.068	0.144	0.289
	(0.398)	(0.293)	(0.410)	(0.448)
JPY spread	0.864 ***	-0.293	0.260	0.058
	(0.222)	(0.248)	(0.305)	(0.361)
NZD spread	0.674 ***	0.347 **	0.081	0.036
	(0.153)	(0.177)	(0.204)	(0.255)
USD spread	-0.492	-0.039	-1.020 ***	-0.417
	(0.340)	(0.223)	(0.325)	(0.383)
Number of observations	106	100	98	97

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 93: Probit of MuniFin's Joint Decision with Month Fixed Effects

Estimator	AUD	CHF	NZD	USD
constant	0.517	0.115	-1.092	-1.438 **
	(0.698)	(1.328)	(0.895)	(0.656)
AUD spread	0.562	-3.233 *	2.649 ***	0.912
	(1.136)	(1.883)	(0.911)	(0.958)
CHF spread	-3.485 *	0.859	0.811	0.502
	(1.852)	(2.100)	(2.017)	(1.515)
JPY spread	3.467 ***	-3.741 ***	0.282	0.899
	(1.222)	(2.272)	(1.321)	(1.333)
NZD spread	3.214 ***	4.113 **	0.052	0.201
	(0.881)	(1.612)	(0.882)	(0.863)
USD spread	-2.280	0.684	-5.415 ***	-1.740
	(1.469)	(1.581)	(1.522)	(1.585)
McFadden R-squared	0.349	0.511	0.195	0.142
Number of observations	90	44	74	81
Number of observations = 1	34	15	22	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 94: Linear Regression of MuniFin's Joint Decision

Estimator	AUD	CHF	NZD	USD
constant	0.315 **	0.237 *	0.242	0.231
	(0.143)	(0.138)	(0.162)	(0.201)
AUD spread	0.098	-0.267	0.640 ***	0.210
	(0.267)	(0.212)	(0.221)	(0.251)
CHF spread	-0.740 *	-0.217	0.097	0.282 **
	(0.417)	(0.256)	(0.389)	(0.465)
JPY spread	0.963 ***	-0.453 *	0.333	0.052
	(0.246)	(0.271)	(0.357)	(0.402)
NZD spread	0.793 ***	0.325	0.110 ***	0.038
	(0.199)	(0.206)	(0.220)	(0.284)
USD spread	-0.650	-0.109	-1.134	-0.404
	(0.405)	(0.305)	(0.162)	(0.397)
R-squared	0.257	0.339	0.112	0.013
Number of observations	106	100	98	97
Number of observations = 1	34	15	22	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 95: Probit of Kommuninvest's Joint Decision

Estimator	AUD	CHF	NZD	USD
constant	-0.294	-2.845	-0.679	-1.781 ***
	(0.701)	(1.982)	(1.072)	(0.659)
AUD spread	-0.877	-3.539	0.708	-0.957
	(0.852)	(2.686)	(1.284)	(0.808)
CHF spread	-1.286	1.461	0.024	0.674
	(0.929)	(1.714)	(1.159)	(0.796)
JPY spread	0.590	-2.201	0.823	0.780
	(1.051)	(1.363)	(1.310)	(1.141)
NZD spread	1.321 *	7.886 ***	2.144 **	-0.736
	(0.741)	(2.871)	(0.845)	(0.733)
USD spread	0.518	-4.666 **	-3.322 **	0.764
	(1.311)	(1.971)	(1.350)	(1.200)
McFadden R-squared	0.055	0.474	0.206	0.051
Number of observations	99	96	96	100
Number of observations = 1	23	7	11	32

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 96: Kommunivest's Joint Decision – Marginal Effects

Estimator	AUD	CHF	NZD	USD
AUD spread	-0.251	-0.269	0.108	-0.324
	(0.243)	(0.197)	(0.191)	(0.268)
CHF spread	-0.369	0.111	0.004	0.228
	(0.262)	(0.140)	(0.177)	(0.266)
JPY spread	0.169	-0.167	0.126	0.264
	(0.301)	(0.122)	(0.197)	(0.384)
NZD spread	0.378 *	0.599 ***	0.328 **	-0.249
	(0.206)	(0.193)	(0.141)	(0.245)
USD spread	0.149	-0.354 **	-0.508 ***	0.258
	(0.375)	(0.149)	(0.197)	(0.404)
Number of observations	99	96	96	100

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 97: Probit of Kommuninvest's Joint Decision with Month Fixed Effects

Estimator	AUD	CHF	NZD	USD
constant	0.128	-	-0.591	-2.628 ***
	(0.985)	-	(1.368)	(0.870)
AUD spread	-1.854	-	0.995	-1.645
	(1.165)	-	(1.550)	(1.009)
CHF spread	-1.617	-	-0.113	1.035
	(1.280)	-	(1.298)	(0.907)
JPY spread	0.125	-	2.445	0.549
	(1.430)	-	(1.548)	(1.286)
NZD spread	2.225 **	-	3.041 ***	-0.993
	(0.918)	-	(1.030)	(0.867)
USD spread	1.345	-	-5.322 ***	1.529
	(2.063)	-	(1.739)	(1.604)
McFadden R-squared	0.203	-	0.206	0.250
Number of observations	67	-	96	92
Number of observations = 1	23	-	11	32

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 98: Linear Regression of Kommuninvest's Joint Decision

Estimator	AUD	CHF	NZD	USD
constant	0.388 *	0.314 **	0.258	-0.122
	(0.224)	(0.155)	(0.197)	(0.210)
AUD spread	-0.237	-0.019	0.183	-0.348
	(0.271)	(0.133)	(0.170)	(0.290)
CHF spread	-0.372	-0.062	0.019	0.252
	(0.281)	(0.144)	(0.180)	(0.291)
JPY spread	0.152	-0.181	0.235	0.225
	(0.346)	(0.226)	(0.318)	(0.370)
NZD spread	0.399	0.582 ***	0.400 **	-0.225
	(0.252)	(0.191)	(0.212)	(0.239)
USD spread	0.135	-0.314	-0.764 **	0.249
	(0.410)	(0.155)	(0.337)	(0.412)
R-squared	0.132	0.243	0.169	0.063
Number of observations	99	96	96	100
Number of observations = 1	23	7	11	32

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 99: Probit of KBN's Joint Decision

Estimator	AUD	NZD	USD
constant	0.522	-0.300	-0.664
	(0.489)	(0.687)	(0.480)
AUD spread	-0.259	2.620	-0.945
	(1.078)	(1.664)	(0.943)
CHF spread	-2.416 ***	-0.499	-0.111
	(0.823)	(0.919)	(0.781)
JPY spread	0.344	1.046	0.130
	(0.945)	(1.202)	(0.916)
NZD spread	1.657 **	-0.918	0.386
	(0.684)	(0.784)	(0.651)
USD spread	1.991	-1.145	0.690
	(1.359)	(1.583)	(1.195)
McFadden R-squared	0.136	0.073	0.021
Number of observations	105	97	99
Number of observations = 1	35	16	37

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 100: KBN's Joint Decision – Marginal Effects

Estimator	AUD	NZD	USD
AUD spread	-0.081	0.615 *	-0.350
	(0.335)	(0.367)	(0.343)
CHF spread	-0.752 ***	-0.117	-0.041
	(0.226)	(0.212)	(0.289)
JPY spread	0.107	0.245	0.048
	(0.294)	(0.274)	(0.339)
NZD spread	0.515 ***	-0.216	0.143
	(0.196)	(0.178)	(0.240)
USD spread	0.619	-0.269	0.256
	(0.410)	(0.366)	(0.440)
Number of observations	105	97	99

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 101: Probit of KBN's Joint Decision with Month Fixed Effects

Estimator	AUD	NZD	USD
constant	0.725	0.314	-1.666 **
	(0.715)	(0.845)	(0.792)
AUD spread	-2.525	2.040	-1.325
	(1.569)	(2.027)	(1.058)
CHF spread	-4.292 ***	-0.799	-0.314
	(1.076)	(1.079)	(0.802)
JPY spread	-0.731	0.105	0.052
	(1.094)	(1.282)	(0.992)
NZD spread	3.108 ***	-0.705	0.399
	(0.847)	(0.862)	(0.696)
USD spread	4.986 ***	-0.041	1.313
	(1.631)	(2.025)	(1.300)
McFadden R-squared	0.294	0.112	0.104
Number of observations	81	65	83
Number of observations = 1	35	16	37

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 102: Linear Regression of KBN's Joint Decision

Estimator	AUD	CHF	NZD	USD
constant	0.669 ***	0.130	0.308 *	0.246
	(0.161)	(0.083)	(0.145)	(0.185)
AUD spread	-0.069	-0.155	0.520 *	-0.358
	(0.367)	(0.150)	(0.251)	(0.372)
CHF spread	-0.782 ***	0.031	-0.126	-0.038
	(0.257)	(0.116)	(0.199)	(0.307)
JPY spread	0.105	-0.062	0.279	0.043
	(0.348)	(0.173)	(0.322)	(0.355)
NZD spread	0.552 **	0.420 ***	-0.214	0.146
	(0.233)	(0.147)	(0.176)	(0.252)
USD spread	0.628	-0.493 *	-0.235	0.263
	(0.445)	(0.253)	(0.390)	(0.457)
R-squared	0.165	0.318	0.371	0.028
Number of observations	105	98	97	99
Number of observations = 1	35	6	16	37

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 103: Probit of Kommunekredit's Joint Decision

Estimator	AUD	CHF	NZD	USD
constant	0.360	-0.678	-0.723	-0.815
	(0.879)	(1.071)	(1.270)	(0.798)
AUD spread	-2.255 **	0.004	0.759	1.190
	(1.111)	(1.313)	(1.481)	(1.119)
CHF spread	0.078	-5.553 ***	-6.038 **	3.799 *
	(1.668)	(1.845)	(2.401)	(2.053)
JPY spread	-3.202 **	1.447	2.038	-1.264
	(1.617)	(1.622)	(1.739)	(1.490)
NZD spread	0.078	1.297	0.093	-0.072
	(1.032)	(1.516)	(0.955)	(1.170)
USD spread	6.102 ***	0.459	0.341	-0.336
	(2.136)	(1.840)	(1.805)	(1.784)
McFadden R-squared	0.129	0.307	0.215	0.092
Number of observations	98	96	96	96
Number of observations = 1	16	7	9	13

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 104: Kommunekredit's Joint Decision – Marginal Effects

Estimator	AUD	CHF	NZD	USD
AUD spread	-0.484 **	0.001	0.100	0.236
	(0.233)	(0.131)	(0.196)	(0.222)
CHF spread	0.017	-0.554 ***	-0.795 **	0.753 *
	(0.358)	(0.185)	(0.339)	(0.404)
JPY spread	-0.687 **	0.144	0.268	-0.251
	(0.345)	(0.175)	(0.217)	(0.295)
NZD spread	0.017	0.129	0.012	-0.014
	(0.221)	(0.150)	(0.126)	(0.232)
USD spread	1.309 ***	0.046	0.045	-0.067
	(0.443)	(0.181)	(0.240)	(0.352)
Number of observations	98	96	96	96

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 105: Probit of Kommunekredit's Joint Decision with Month Fixed Effects

Estimator	AUD	CHF	NZD	USD
constant	1.481	-0.087	2.437	-0.847
	(0.975)	(1.311)	(2.023)	(1.243)
AUD spread	-5.166 ***	-0.410	2.892 *	1.866
	(1.761)	(1.947)	(1.552)	(1.409)
CHF spread	-1.719	-4.189 ***	-12.731 **	5.830 **
	(2.157)	(1.625)	(5.486)	(2.312)
JPY spread	-5.141 **	0.074	2.263	-1.791
	(2.250)	(1.757)	(3.620)	(1.824)
NZD spread	0.402	1.337	1.679	-0.187
	(1.179)	(1.530)	(1.799)	(1.245)
USD spread	12.381 ***	0.666	-0.939	-0.317
	(3.385)	(2.841)	(2.904)	(2.367)
McFadden R-squared	0.322	0.363	0.515	0.287
Number of observations	74	40	56	56
Number of observations = 1	16	7	9	13

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 106: Linear Regression of Kommunekredit's Joint Decision

Estimator	AUD	CHF	NZD	USD
constant	0.382 *	0.154	0.097	0.207
	(0.212)	(0.098)	(0.133)	(0.175)
AUD spread	-0.376	-0.186	-0.014	0.143
	(0.243)	(0.195)	(0.217)	(0.162)
CHF spread	-0.026	-0.539 **	-0.650 **	0.674 **
	(0.440)	(0.211)	(0.306)	(0.474)
JPY spread	-0.441	0.018	0.239	-0.299
	(0.320)	(0.174)	(0.177)	(0.355)
NZD spread	0.058	0.155	0.002	0.015
	(0.231)	(0.157)	(0.116)	(0.252)
USD spread	0.906 ***	0.093	-0.067	-0.110
	(0.212)	(0.297)	(0.395)	(0.273)
R-squared	0.083	0.198	0.128	0.056
Number of observations	98	96	96	96
Number of observations = 1	16	7	9	13

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

The power of the data

Given that relatively few 'currency spread' regressors are significant in the above results, I undertake linear regressions to test the power of the data. The dependent variable is the ordered choice of the six currencies for the pooled sample of 636 bond issues (0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD).

Table 107: Linear Regression of the Joint Issue Decision in One of Six Currencies

Estimator	Model 1	Model 2	Model 3	Model 4
constant	2.136 ***	1.810 ***	-0.103	-1.185
	(0.247)	(0.352)	(1.719)	(2.212)
AUD spread	1.461 ***	1.455 ***	-0.930	-0.810
	(0.453)	(0.460)	(1.909)	(1.936)
CHF spread	1.778 ***	2.077 ***	3.722 **	4.379 ***
	(0.474)	(0.550)	(1.515)	(1.685)
JPY spread	-0.255	-0.580	-0.097	-0.405
	(0.388)	(0.446)	(0.589)	(0.618)
NZD spread	-0.858 **	-0.924 **	0.810	-0.177
	(0.355)	(0.370)	(1.982)	(2.124)
USD spread	-1.604 ***	-1.491 **	-3.049	-2.781
	(0.619)	(0.627)	(2.084)	(2.222)
R-squared	0.041	0.050	0.180	0.188
Number of observations	636	636	636	636
Issuer FE	no	yes	no	yes
Month FE	no	no	yes	yes

Source: Calculated; robust standard errors; key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 2009-Dec 2016

All 'currency spread' regressors except JPY are significant in the base model and the model with issuer fixed effects. In general, the linear regressions underline some predictive power in the AUD, CHF, NZD and USD spread data. The JPY data may suffer from a relatively small number of observations. However, once month fixed effects are introduced to the models, only the CHF spread remains a significant regressor, even though the R-squared of these regressions improves. Similar results are generated if I include annual fixed effects (not reported).

Multinomial regression: currency choice relative to home currency

To investigate the issuer's choice between different foreign currencies, relative to issuing at home, I create a multinomial probit regression of the pooled sample of all 636 bond issues. None of the regressors — AUD spread for AUD issuance, CHF spread for CHF issuance, JPY spread for JPY issuance, NZD spread for NZD issuance and USD spread for USD issuance — is significant. Three of the regressors in the choice of CHF over home issuance are significant. However, the signs of the coefficients of the AUD and JPY spreads are negative. Three of the regressors in the choice of NZD over home issuance are significant. However, the sign of the coefficient of the USD spread is negative.

Table 108: Multinomial Probits of Currency Choice on 'Currency Spread'

Currency Mode	Coefficient	Standard Error	Coefficient with Month Fixed Effects	Standard Error with Month Fixed Effects
Australian dollar				
c	-0.083	0.272	0.637	0.695
Spread AUD	-0.415	0.473	-0.611	0.491
Spread CHF	-0.400	0.516	-0.574	0.530
Spread JPY	0.689	0.428	0.736	0.449
Spread NZD	0.728 **	0.370	0.767 **	0.383
Spread USD	0.422	0.694	0.768	0.717
Swiss franc				
c	-0.661 *	0.358	-12.994 ***	0.767
Spread AUD	-1.827 ***	0.658	-1.710 ***	0.656
Spread CHF	-0.429	0.630	-0.250	0.648
Spread JPY	-1.218 **	0.526	-0.929 *	0.556
Spread NZD	2.644 ***	0.552	2.654 ***	0.552
Spread USD	-0.367	0.760	-0.674	0.829
Home	(base outcome)			
Japanese yen				
c	-0.170	0.786	-10.411 ***	1.510
Spread AUD	4.029 ***	1.478	5.068 *	2.907
Spread CHF	-2.585	1.615	-3.556 **	1.774
Spread JPY	0.080	0.986	-4.835 **	2.359
Spread NZD	-0.424	0.731	-4.034 *	2.202
Spread USD	-2.650 *	1.357	-1.570	2.470
New Zealand dollar				
c	-0.453	0.321	0.305	0.794
Spread AUD	1.350 **	0.573	1.087 *	0.591
Spread CHF	0.993 *	0.569	0.794	0.586
Spread JPY	0.204	0.468	0.164	0.507
Spread NZD	0.090	0.399	0.225	0.422
Spread USD	-2.020 ***	0.766	-1.632 **	0.822
US dollar				
c	-0.247	0.263	-0.198	0.741
Spread AUD	0.841 *	0.476	0.745	0.490
Spread CHF	1.271 **	0.509	1.111 **	0.514
Spread JPY	0.127	0.426	0.379	0.445
Spread NZD	-0.544	0.382	-0.547	0.393
Spread USD	-0.731	0.685	-0.483	0.703

Source: Calculated, robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16; observations 636, log likelihood -928.9 for base model, -878.1 for fixed effects model

There is little additional information in the model with monthly fixed effects (not reported). Regressors reflect those of the base probit model. The results of Table 108 are repeated by individual issuer in Tables 138 to 143 in the Appendix.

Marginal effects of the multinomial probit model

Marginal effects indicates how the probability of the dependent variable changes when I change the value of a regressor, holding all other regressors constant across the pooled sample of Table 108. None of the coefficients of change in CHF spread for CHF bond issuance, change in JPY spread for JPY issuance, change in NZD spread for NZD issuance and change in USD spread for USD issuance relative to home issue are significant. Only the change in AUD regressor for AUD issuance is significant, and it is negative. As this 'currency spread' becomes more negative, the agencies are more likely to issue in AUD. All of the other spread regressors for the decision to issue in AUD are significant and three of the four non-AUD spread regressors are positive, which I would expect (as non-AUD spread regressors become more positive, so the agencies are more likely to issue in AUD).

Table 109: Multinomial Probit Marginal Effects on Changes in 'Currency Spreads'

Currency Mode	AUD	CHF	JPY	NZD	USD
Spread AUD	-0.203 *	-0.236 ***	0.013	0.232 ***	0.250 **
	(0.022)	(0.058)	(0.014)	(0.079)	(0.106)
Spread CHF	-0.257 **	-0.089	-0.010	0.131	0.346 ***
	(0.112)	(0.063)	(0.010)	(0.085)	(0.111)
Spread JPY	0.199 **	-0.161 ***	-0.001	0.014	-0.002
	(0.092)	(0.055)	(0.005)	(0.068)	(0.094)
Spread NZD	0.161 **	0.281 ***	-0.003	-0.038	-0.298 ***
	(0.081)	(0.050)	(0.005)	(0.061)	(0.081)
Spread USD	0.292 **	0.004	-0.008	-0.313 ***	-0.123
	(0.148)	(0.077)	(0.010)	(0.107)	(0.152)

Source: Calculated, robust standard errors; key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period is Jan 09-Dec 16; observations 636; data measure marginal change in the decision to issue in a given currency for a change in respective variable

Other motivations for foreign currency choice

Does the size of the bond issue matter?

A further question is whether the size of the bond that the MBAs wish to issue is related to their choice of issuing-currency? Both the size and currency of a bond issue are choice variables, so establishing causality is not straightforward. I arbitrarily assume that the MBAs first decide on the size of their bond issue and then decide to issue in a given foreign currency. Table 110 summarises a pooled regression of the choice of currency relative to the home currency of the issuer on the amount issued in euros. This excludes 'currency spreads'. Every 'amount issued' regressor of interest except the USD is significant and negative; and every coefficient within the marginal effects table is significant.

The marginal effects results of Table 111 suggest that as the size of bond issue increases, an MBA is less likely to issue in AUD, CHF, JPY or NZD and more likely to issue at home or in USD, assuming they have first decided on its size.

Table 110: Multinomial Probit of Currency Choice on Amount Issued

Currency Mode	Coefficient	Standard Error	P-value
Australian dollar			
c	0.681 ***	0.107	0.000
Amount issued	-0.003 ***	0.000	0.000
Swiss franc			
c	-0.009	0.121	0.939
Amount issued	-0.002 ***	0.000	0.000
Home	(base outcome)		
Japanese yen			
c	-1.061 ***	0.202	0.000
Amount issued	-0.002 **	0.001	0.018
New Zealand dollar			
c	0.320 **	0.128	0.013
Amount issued	-0.006 ***	0.001	0.000
US dollar			
c	-0.155	0.109	0.154
Amount issued	0.000	0.000	0.111

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16; observations 636; log likelihood -872.6

Table 111: Multinomial Probit Marginal Effects on Currency on Amount Issued

Currency Mode	HOME	AUD	CHF	JPY	NZD	USD
Amount issued	0.0004 *** (0.0001)	-0.0005 *** (0.0001)	-0.0002 *** (0.000)	-0.0001 *** (0.000)	-0.0001 * (0.0001)	0.0005 *** (0.0001)

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16

Does the size of available markets matter?

The size of a foreign market is exogenous. Should the size of the available market be a good regressor? As a preliminary, I undertake an OLS regression of size of bond issued on size of market chosen. The Bank of International Settlements (BIS) definition for available foreign bond markets is followed, namely, 'national issuers/other financial corporations/debt securities issued and amount'. I create a quarterly time series over 2009-16. The USD market is much the largest relevant market with an average size of US$1,616 billion, followed by AUD at US$102 billion, JPY at US$76 billion, CHF at US$37 billion and NZD at US$10 billion. The USD is also the MBAs' largest currency of bond issuance. By the end of 2016, 44.8% of all outstanding bonds of European MBA issuers were denominated in US dollars – more than their combined home currency issuance. Table 112 suggests a positive and significant relationship between the size of markets and the size of the bond issue.

Table 112: Regression of Size of Bond Issued on Market Size of Currency Chosen

Estimator	OLS
Constant	177.7
	(28.8)
Size of chosen market	0.266 ***
	(0.023)
number of observations	636
R-squared	0.177
F-statistic	136.2

Source: Calculated; key: robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$, amount issued and market size both measured in euros, the former in millions, the latter in billions

Mizen et al. (2012) argue for a market depth hypothesis, namely that the choice of market for corporate bond issuance is determined by its ability to accommodate borrower demands. In light of this, I investigate the size of foreign bond markets as a regressor to the choice of the foreign currency of issuance, in addition to 'currency spread'. I repeat the multinomial regression of Table 108 in Table 113 with market size added as a control variable. I follow Chinn and Ito (2000), and include the log (market size in € million) of the respective available foreign currency bond markets as an instrument. There is little improvement in the significance of the 'currency spread' regressors from Table 108 to 113. None of the coefficients of the AUD spread for AUD issuance, CHF spread for CHF issuance, JPY spread for JPY issuance or NZD spread for NZD issuance is significant. USD spread for USD issuance regressor is significant and negative. Most market size regressors are significant in the choice of AUD over home issuance, but not the AUD market size. I also include results of the multinomial regression with month fixed effects.

Table 113: Multinomial Probit of Currency Choice on 'Currency Spread' and Market Size

Currency Mode	Coefficient	Standard Error	Coefficient with Month FE	Standard Error with FE
Australian dollar				
C	-9.414	49.604	-10.486	50.890
Spread AUD	0.492	0.720	0.588	0.740
Spread CHF	0.564	0.680	0.298	0.720
Spread JPY	-0.113	0.557	0.015	0.579
Spread NZD	1.059	0.807	0.701	0.840
Spread USD	-2.305 **	0.939	-1.862 *	1.022
log size AUD	6.667	7.760	8.775	8.043
log size CHF	2.961 *	1.547	2.707 *	1.589
log size HOME	-0.179 ***	0.065	-0.193 ***	0.066
log size JPY	-5.625 **	2.602	-4.008	2.754
log size NZD	0.686 **	0.312	0.598 *	0.336
log size USD	-1.068	7.383	-2.925	7.790
Swiss franc				
C	0.575	60.056	-14.495	68.202
Spread AUD	-1.548	0.950	-1.638	1.099
Spread CHF	-0.177	0.850	0.350	0.959
Spread JPY	-1.696 **	0.718	-1.295 *	0.720
Spread NZD	2.991 ***	1.014	3.423 ***	1.177
Spread USD	-1.543	1.076	-2.590 *	1.245
log size AUD	11.306	10.204	8.243	10.811
log size CHF	-0.274	1.901	1.423	2.244
log size HOME	-0.102	0.084	-0.135	0.089
log size JPY	-2.955	3.883	-7.435	4.893
log size NZD	0.334	0.387	0.461	0.408
log size USD	-5.349	9.893	-1.419	10.505
Home	(base outcome)			
Japanese yen				
C	46.916	146.005	367.351	-
Spread AUD	6.538 ***	1.616	9.280 ***	2.871
Spread CHF	-0.649	2.113	2.387	6.146
Spread JPY	-0.695	1.654	-10.403	8.820
Spread NZD	-3.232	2.120	-10.966 **	4.295
Spread USD	-3.955 **	1.691	0.689	3.979
log size AUD	7.348	11.258	25.432	33.680
log size CHF	5.602 *	3.147	6.661	4.982
log size HOME	0.565 ***	0.185	2.071	2.049
log size JPY	5.193	8.438	31.913 **	16.262
log size NZD	-0.368	0.740	-2.603	1.726
log size USD	-17.271	20.323	-90.528 *	39.686
New Zealand dollar				
C	36.176	58.038	59.844	64.032
Spread AUD	2.744 ***	0.843	2.967 ***	0.908
Spread CHF	1.787 **	0.775	1.415 *	0.843
Spread JPY	0.430	0.608	0.638	0.656
Spread NZD	-1.617	0.987	-2.534**	1.133
Spread USD	-3.200 ***	1.052	-2.147 *	1.212
log size AUD	11.155	8.260	20.457 **	8.788
log size CHF	2.515	1.668	1.694	1.777
log size HOME	-0.185 **	0.073	-0.182 **	0.076
log size JPY	-2.263	3.146	0.874	3.623
log size NZD	-0.204	0.377	-0.607	0.448
log size USD	-11.685	8.859	-21.940 **	10.032
US dollar				
C	-60.643	51.066	-73.239	55.525
Spread AUD	0.919	0.716	0.740	0.758
Spread CHF	1.821 **	0.719	1.478 *	0.759
Spread JPY	-0.364	0.557	-0.090	0.575
Spread NZD	-0.020	0.854	-0.077	0.898
Spread USD	-2.187 **	0.978	-1.769 *	1.059
log size AUD	15.375 **	7.754	18.038 **	8.245
log size CHF	-1.027	1.437	-1.672	1.543
log size HOME	-0.098	0.064	-0.120 *	0.066
log size JPY	-5.578 **	2.740	-5.093 *	2.922
log size NZD	0.570 *	0.325	0.574	0.354
log size USD	2.256	7.451	2.353	8.037

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16; observations 675; log likelihood -898.4 for base model, 850.5 for fixed effects model

I include a marginal effects analysis below. There is little additional information in this table, except that the marginal effects of the NZD spread regressor and NZD market size regressor for NZD currency issuance relative to home issuance choice are both significant.

Table 114: Probit Marginal Effects of Currency Choice: Market Size Included

	AUD	CHF	JPY	NZD	USD
Spread AUD	-0.034 (0.158)	-0.270 *** (0.102)	0.002 (0.003)	0.400 *** (0.115)	0.123 (0.161)
Spread CHF	-0.097 (0.143)	-0.128 (0.085)	-0.001 (0.001)	0.176 * (0.104)	0.363 ** (0.159)
Spread JPY	0.037 (0.117)	-0.186 *** (0.070)	-0.001 (0.001)	0.121 (0.080)	-0.054 (0.121)
Spread NZD	0.264 (0.177)	0.338 *** (0.112)	-0.001 (0.002)	-0.359 *** (0.136)	-0.124 (0.194)
Spread USD	-0.212 (0.205)	0.022 (0.107)	-0.001 (0.001)	-0.275 * (0.144)	-0.177 (0.222)
log size AUD	-0.531 (1.633)	0.389 (1.019)	-0.001 (0.003)	0.550 (1.091)	2.661 (1.667)
log size CHF	0.774 ** (0.335)	-0.135 (0.193)	0.002 (0.003)	0.320 (0.223)	-0.667 ** (0.320)
log size HOME	-0.027 * (0.014)	0.001 (0.009)	0.001 (0.001)	-0.015 (0.010)	0.002 (0.014)
log size JPY	-0.778 (0.573)	0.057 (0.407)	0.003 (0.006)	0.216 (0.447)	-0.790 (0.618)
log size NZD	0.128 * (0.068)	0.002 (0.039)	-0.001 (0.001)	-0.098 ** (0.052)	0.090 (0.073)
log size USD	0.218 (1.615)	-0.450 (1.012)	-0.005 (0.012)	-1.843 (1.243)	1.450 (1.673)

Source: Calculated; robust standard errors key: the data measure the marginal change in the decision to issue in a given currency, given a change in the respective variable. Observation period Jan 09-Dec 16

Other robustness checks

1. CDS spreads are tested to see if counterparty risk is a factor in currency choice. The MBAs collateralise all interest rate and cross-currency basis swaps, so I do not expect global bank credit default swap spreads to be significant regressors. The univariate regressions of Table 59 to 82 are repeated by adding the global bank CDS (not reported). At no stage is this regressor significant and its inclusion only improves the significance of the 'currency spread' regressor in the cases of Kommuninvest's decision to issue CHF bonds. Table 115 shows the results of multinomial regressions with Bank CDS added to the usual 'currency spread' regressors. The only global bank CDS regressor that is significant is for the choice to issue in USD. It is negative, which suggests that when CDS spreads are rising, then MBAs are less likely to seek the USD for issuance. In general the 'currency spread' regressors of Table 115 are no more significant than those of Table 108.

2. Does USD benchmarking influence currency choice? All of the MBAs issue large benchmark bond issues to populate and enrich a municipal bond yield curve or replace maturing benchmark bonds in USD, as well as in some of their respective domestic currencies. USD benchmark programmes represent a large percentage of the USD funding of BNG, MuniFin and Kommuninvest. As highlighted from Tables 59 to 82, the coefficient of the USD covered 'currency spread' is not significant for five MBAs and only significant for Kommuninvest within their respective univariate probit regressions. It is positive for the latter, which is to say the worse the 'currency spread', the more likely Kommuninvest is to issue in USD – a counter-intuitive result. If the timing of USD benchmark bonds issuance is determined by the redemption or refunding of existing benchmark constituents, might these influence issue-timing? The effect of replacing benchmark bonds at redemption on the timing of fixed coupon bond issues in USD is investigated by a probit regression analysis. I lack available disclosure to tag USD bond benchmark issues, so to find a suitable regression instrument, I identify all fixed coupon USD-denominated bonds with an issue value of at least US$500 million as a proxy for benchmark bonds. In practice, there may be fewer benchmark bonds than these. I then create a dummy variable of whether an MBA has issued a USD bond within 30 days of the redemption of one of these bonds. Table 117 shows these regressors are not significant for BNG and NWB. On the other hand, the regressors are positive and significant for Kommuninvest and KBN. These MBAs have often issued bonds in USD when the covered 'currency spread' was against them. The regressions are repeated with 'was a bond issued less than 30 days <u>after</u> a redemption?' as a regressor with similar results (not reported).

3. Is there a delay in the decision-making process to base the currency choice on 'currency spread'? McBrady and Schill (2007) suggest that decision makers may use lagged data to inform their decision to issue in a foreign currency. I substitute a one-week lag of the foreign 'currency spreads' into the regressions of Table 108. I show the results of the multinomial regression in Table 118 and marginal effects in Table 119. The significance of the spreads coefficients is practically unchanged from Tables 108 to 118 and the latter's coefficients are close to the coefficients within Table 108. At least three coefficients are significant in each of the CHF, NZD and USD sections of the marginal effects table and all coefficients are significant in the AUD section. However, only the change in the AUD spread regressor is negative in the AUD choice; while the equivalent changes in CHF, NZD and USD spread regressors are not significant within their respective CHF, NZD and USD choice sections. For decision-makers to react to lagged data, I would expect these particular regressors to be negative and significant.

4. All five foreign currencies belong to countries ranked within the top 34 globally for ease of doing business by the World Bank over 2009-16. I investigate whether the currency choice of the MBA bond issuers is influenced by relative changes in the ease of doing business over time. These rankings are only updated on an annual basis. When adding 'ease of doing business' regressors by country to the usual 'currency spread' regressors and undertaking multinomial regressions, only the NZD regressor is significant across-currency choices (results not reported).

5. Do Euro Area issuers act differently from non-Euro Area issuers? Does grouping issuers by those with and without joint and several guarantee generate different results? Relative to the multinomial probit regression of Table 108, I undertake regressions that include dummies for euro-domiciled issuers and 'joint and several guarantee' issuers to determine whether these issuers exhibit different behaviours. Neither regressor is significant in their respective regressions (results not reported).

6. Do MBAs issue where they already have a large presence of bonds outstanding? I investigate whether an MBA will issue in a particular currency, dependent upon how much bond issuance they have already undertaken in that currency. This is measured relative to the available market size, as defined by the Bank of International Settlements (BIS). NWB, MuniFin, Kommuninvest and Kommunekredit publish outstanding bonds analysis. I regress these MBAs' currency choice dummy on foreign 'currency spread' and the percentage of bonds outstanding in that currency, relative to the BIS available market size. In general, the evidence is weak (results not reported).

Table 115: Multinomial Probit of Currency Choice on 'Currency Spread' and Bank CDS Controls

Currency Mode	Coefficient	Standard Error	Coefficient with Month FE	Standard Error with Month FE
1 Australian dollar				
c	-0.092	0.268	0.642	0.696
Spread AUD	-0.172	0.540	-0.449	0.563
Spread CHF	-0.830	0.629	-0.842	0.647
Spread JPY	0.552	0.442	0.659	0.463
Spread NZD	0.613	0.400	0.709 *	0.418
Spread USD	0.785	0.742	0.974	0.769
Global bank CDS	0.003	0.002	0.002	0.002
2 Swiss franc				
c	-0.657 *	0.358	-12.756 ***	0.771
Spread AUD	-1.833 ***	0.686	-1.962 ***	0.724
Spread CHF	-0.447	0.849	0.174	0.823
Spread JPY	-1.224 **	0.545	-0.883	0.569
Spread NZD	2.651 ***	0.562	2.831 ***	0.0597
Spread USD	-0.345	0.941	-1.083	0.961
Global bank CDS	0.000	0.003	-0.002	0.003
3 Home	(base outcome)			
4 Japanese yen				
c	0.110	0.993	-9.600	-
Spread AUD	3.515 ***	1.310	3.055	3.005
Spread CHF	-1.876	1.517	-2.395	1.534
Spread JPY	0.069	1.059	-3.204	2.270
Spread NZD	-0.096	0.870	-2.050	2.283
Spread USD	-3.576 **	1.587	-3.351	2.857
Global bank CDS	-0.007	0.005	-0.014 *	0.007
5 New Zealand dollar				
c	-0.479	0.311	0.311 *	0.790
Spread AUD	1.653 **	0.658	1.269	0.681
Spread CHF	0.529	0.687	0.509	0.725
Spread JPY	0.045	0.480	0.073	0.514
Spread NZD	-0.123	0.460	0.109	0.481
Spread USD	-1.576 *	0.838	-1.371	0.899
Global bank CDS	0.003	0.003	0.002	0.003
6 US dollar				
c	-0.231	0.273	-0.180	0.742
Spread AUD	0.309	0.547	0.121	0.571
Spread CHF	1.894 ***	0.608	1.786 ***	0.610
Spread JPY	0.389	0.458	0.633	0.481
Spread NZD	-0.232	0.404	-0.189	0.423
Spread USD	-1.214	0.747	-0.986	0.766
Global bank CDS	-0.004 *	0.002	-0.005 *	0.002

Source: Calculated; robust standard errors; key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16; observations 636, log likelihood -922.9 for base model, -873.2 for fixed effects model

Table 116: Marginal Effects of the Probit of Currency Choice: Bank CDS Included

	HOME	AUD	CHF	JPY	NZD	USD
Spread AUD	-0.042 (0.123)	-0.102 (0.117)	-0.234 *** (0.063)	0.008 (0.009)	0.299 *** (0.093)	0.071 (0.119)
Spread CHF	-0.115 (0.137)	-0.407 *** (0.140)	-0.090 (0.083)	-0.005 (0.005)	0.044 (0.098)	0.572 *** (0.136)
Spread JPY	-0.054 (0.099)	0.147 (0.097)	-0.164 *** (0.053)	0.000 (0.002)	-0.018 (0.068)	0.089 (0.102)
Spread NZD	-0.115 (0.091)	0.111 (0.087)	0.281 *** (0.052)	-0.001 (0.002)	-0.084 (0.065)	-0.192 ** (0.088)
Spread USD	0.136 (0.165)	0.411 ** (0.164)	0.003 (0.092)	-0.007 (0.010)	-0.235 * (0.120)	-0.307 * (0.168)
CDS	0.000 (0.001)	0.001 * (0.001)	0.000 (0.000)	0.000 (0.000)	0.001 (0.001)	-0.002 *** (0.001)

Source: Calculated; robust standard errors; key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16; the data measure the marginal change in the decision to issue in a given currency, given a change in the respective variable

Table 117: Probit of USD Issue Decision on Proximity to Benchmark Bond Redemptions and Deviation from CIP

Estimator	BNG	BNG	NWB	NWB	KBN	KBN	Kommu -ninvest	Kommu-ninvest
Constant	-0.078 (0.223)	0.912 (0.608)	-0.408 ** (0.203)	0.785 (0.766)	-0.084 (0.189)	-0.161 (0.554)	-0.128 (0.181)	-1.482 * (0.772)
Less than 30 days	0.135 (0.293)	0.117 (0.319)	0.342 (0.354)	0.240 (0.383)	0.925 ** (0.373)	1.034 ** (0.409)	0.694 * (0.401)	0.517 (0.435)
Spread AUD		1.938 ** (0.957)		-0.005 (1.224)		-1.457 (1.161)		-0.835 (1.078)
Spread CHF		2.590 * (1.548)		3.556 ** (1.605)		-0.856 (0.976)		0.684 (1.004)
Spread JPY		-1.315 (1.218)		-1.897 (1.478)		0.054 (1.057)		0.404 (1.406)
Spread NZD		-0.365 (0.765)		1.008 (1.146)		0.089 (0.797)		-1.831 ** (0.876)
Spread USD		-1.555 (1.560)		0.481 (1.650)		1.536 (1.530)		2.009 (1.538)
Log likelihood	-52.6	-48.0	-39.5	-35.8	-41.1	-40.2	-42.1	-36.6
McFadden R-squared	0.002	0.088	0.012	0.105	0.075	0.096	0.036	0.161
Number of observations = 1	38	38	23	23	37	37	32	32
Number of observations = 0	38	38	37	37	28	28	31	31

Source: Calculated; robust standard errors; key: the dependent variable takes the value 0 for no issue in that currency in a month when the MBA issued a foreign currency bond, 1 for an issue in that currency. Observation period Jan 09-Dec 16

Table 118: Multinomial Probit of Currency Choice on a One-week Lag of 'Currency Spreads'

Currency Mode	Coefficient	Standard Error	Coefficient with Month FE	Standard Error with Month FE
1 Australian dollar				
c	-0.052	0.280	0.670	0.704
Lag spread AUD	-0.529	0.466	-0.766	0.487
Lag spread CHF	-0.442	0.504	-0.646	0.522
Lag spread JPY	0.567	0.436	0.572	0.459
Lag spread NZD	0.782 **	0.369	0.838 **	0.384
Lag spread USD	0.556	0.683	0.964	0.712
2 Swiss franc				
c	-0.728 **	0.363	-13.324 ***	0.562
Lag spread AUD	-2.029 ***	0.648	-1.820 ***	0.645
Lag spread CHF	-0.364	0.618	-0.159	0.640
Lag spread JPY	-1.351 ***	0.525	-1.062 *	0.544
Lag spread NZD	2.698 ***	0.559	2.670 ***	0.544
Lag spread USD	-0.203	0.749	-0.600	0.820
3 Home	(base outcome)			
4 Japanese yen				
c	-0.338	0.733	-10.585 ***	1.292
Lag spread AUD	3.200 **	1.348	3.686	2.586
Lag spread CHF	-2.328	1.521	-3.943 **	1.830
Lag spread JPY	-0.010	0.943	-2.806	2.184
Lag spread NZD	-0.197	0.766	-1.589	1.518
Lag spread USD	-2.191	1.425	-1.362	2.682
5 New Zealand dollar				
c	-0.417	0.330	0.348 **	0.804
Lag spread AUD	1.504 ***	0.573	1.313	0.603
Lag spread CHF	1.059 *	0.563	0.955	0.587
Lag spread JPY	0.185	0.478	0.126	0.520
Lag spread NZD	0.035	0.393	0.144	0.416
Lag spread USD	-2.164 ***	0.769	-1.895 **	0.851
6 US dollar				
c	-0.188	0.268	-0.136	0.752
Lag spread AUD	0.775 *	0.471	0.690 **	0.487
Lag spread CHF	1.176 **	0.499	0.999	0.509
Lag spread JPY	0.060	0.436	0.276	0.453
Lag spread NZD	-0.503	0.380	-0.521	0.394
Lag spread USD	-0.579	0.678	-0.292	0.705

Source: Calculated; robust standard errors; key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16; observations 636, log likelihood -929.5 for base model, -877.6 for fixed effects model

Table 119: Marginal Effects of the Probit of Currency Choice: Lags of Spreads Included

	HOME	AUD	CHF	JPY	NZD	USD
Lag spread AUD	-0.042 (0.105)	-0.230 ** (0.102)	-0.254 *** (0.056)	0.017 (0.011)	0.266 *** (0.080)	0.242 ** (0.104)
Lag spread CHF	-0.111 (0.113)	-0.264 ** (0.109)	-0.078 (0.059)	-0.015 (0.009)	0.146 * (0.078)	0.321 *** (0.109)
Lag spread JPY	-0.027 (0.097)	0.177 * (0.096)	-0.168 *** (0.050)	-0.001 (0.005)	0.023 (0.067)	-0.004 (0.097)
Lag spread NZD	-0.112 (0.084)	0.175 ** (0.080)	0.282 *** (0.049)	-0.001 (0.005)	-0.052 (0.053)	-0.291 *** (0.083)
Lag spread USD	0.122 (0.152)	0.316 ** (0.148)	0.016 (0.068)	-0.010 (0.010)	-0.350 *** (0.105)	-0.093 (0.148)

Source: Calculated; robust standard errors; key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period Jan 09-Dec 16; the data measure the marginal change in the decision to issue in a given currency, given a change in the respective variable

CONCLUDING REMARKS

The majority of European MBA bonds are issued in a foreign currency. This is the first study to measure the effectiveness of such a policy of bond issuance.

Covered Interest Parity has failed to hold for many five-year cross-currency basis swaps since at least 2004, providing an opportunity to reduce interest costs when timing foreign currency bond issuance. Most of the time, European MBAs do take advantage of lapses in CIP. However, probit regressions suggest that currency deviations from CIP rarely influence their timing of decisions to issue bonds in a foreign currency. For example, MBA bond issuers do not appear to be concerned about timing issues in AUD and NZD, where covered 'currency spreads' are nearly always favourable relative to their respective domestic currencies. Furthermore, bonds are often issued in the most popular foreign currency, the USD, when covered 'currency spreads' with the AUD and NZD are more favourable. The exception is the CHF, where MBAs are sensitive to swap spreads when timing bond issuance. Yet the 'currency spread' here is often against them, which presents a puzzle as to why an MBA should issue bonds in a currency that often had an unfavourable deviation from CIP from 2011 and when AUD and NZD spreads were frequently more attractive?

Do other funding objectives override CIP considerations? I identify a relationship between the size of bond chosen and the size of foreign currency market of issue. Furthermore, each agency maintains benchmark bonds in USD, and replacing maturing benchmark constituents influences the timing of the USD bond issuance of KBN and Kommuninvest. However, the USD 'currency spread' is often against KBN, which rarely makes interest cost savings relative to hypothetical domestic bond issuance when issuing USD denominated bonds.

Over an eight-year observation window, the adopted sample of fixed maturity-date bonds for regression analysis represents 44% of all MBA bonds issued in 23 currencies. Most of the exclusions include dual currency bonds, exotic pay-off bonds, and currencies with no swap data or insufficient issuance activity for meaningful regression results. While four MBAs generate interest cost savings over 90% of the time, I find limited evidence that MBA bond issuers act optimally in timing the issuing of foreign currency bonds through the failure of CIP. If interest savings are the prime motivation for foreign bond issuance, some MBAs could improve on their record.

APPENDIX

Univariate joint decision to issue in one currency – first bond issue of a month

Tables 120 to 125 present the agency's joint decision to issue a bond and to issue in a given foreign currency. In this case, probit regressions include just the first bond issued in a month, when more than one bond has been issued in the same currency, which contrasts with the analysis of Table 59, for example, which includes all bonds issued in the period of review. A univariate regression restricts the agency to looking at the 'currency spread' of just one foreign currency relative to its domestic currency. In a month when a bond is issued in a foreign currency, the 'currency spread' is calculated on the curve date for the first respective issue. If there is a month with no issue, the 'currency spread' is calculated as the average of the month-start and month-end values. The more negative a 'currency spread' is, the more attractive that currency is to issue in relative to the domestic currency. Thus, I look for a negative and significant regression coefficient to indicate that an issuer's decision to issue in that foreign currency is sensitive to that spread. Results closely reflect those of Tables 59 to 82.

Table 120: Probit of BNG's Joint Decision in a Particular Currency (observing only the first issue in a month of issue)

Estimator	AUD	CHF	JPY	NZD	USD
constant	-0.974 *** (0.396)	-1.003 *** (0.170)	-1.243 *** (0.340)	-0.881 * (0.457)	-0.101 (0.278)
AUD spread	-0.699 (0.454)				
CHF spread		-2.407 ** (0.957)			
JPY spread			-3.082 ** (1.255)		
NZD spread				0.457 (0.732)	
USD spread					0.491 (0.637)
McFadden R-squared	0.019	0.090	0.273	0.005	0.005
Number of observations = 1	33	13	3	12	37
Number of observations = 0	63	83	93	84	59

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 121: Probit of NWB's Joint Decision in a Particular Currency (observing only the first issue in a month of issue)

Estimator	AUD	CHF	JPY	NZD	USD
constant	-1.938 ***	-1.072 ***	-1.126 ***	-6.655 ***	-0.425
	(0.491)	(0.180)	(0.310)	(1.807)	(0.320)
AUD spread	-0.981 *				
	(0.530)				
CHF spread		-3.329 ***			
		(1.039)			
JPY spread			-2.751 **		
			(1.130)		
NZD spread				-5.326 **	
				(2.299)	
USD spread					0.837
					(0.776)
McFadden R-squared	0.045	0.167	0.192	0.351	0.012
Number of observations = 1	13	12	4	1	22
Number of observations = 0	83	84	92	95	74

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 122: Probit of MuniFin's Joint Decision in a Particular Currency (observing only the first issue in a month of issue)

Estimator	AUD	CHF	NZD	USD
constant	-0.793	-1.101 ***	-0.524	-0.750 ***
	(0.417)	(0.182)	(0.429)	(0.282)
AUD spread	-0.147			
	(0.488)			
CHF spread		-2.610 ***		
		(0.868)		
NZD spread			0.494	
			(0.697)	
USD spread				-0.022
				(0.634)
McFadden R-squared	0.001	0.150	0.005	0.000
Number of observations = 1	24	11	20	22
Number of observations = 0	72	85	76	74

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 123: Probit of Kommuninvest's Joint Decision in a Particular Currency (observing only the first issue in a month of issue)

Estimator	AUD	CHF	NZD	USD
constant	-0.904	-0.958	-1.177 ***	-0.827 ***
	(0.223)	(0.488)	(0.170)	(0.201)
AUD spread	-0.340			
	(0.621)			
CHF spread		-0.688		
		(0.643)		
NZD spread			0.733	
			(0.591)	
USD spread				1.104 **
				(0.559)
McFadden R-squared	0.003	0.024	0.022	0.036
Number of observations = 1	20	7	11	28
Number of observations = 0	76	89	85	68

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 124: Probit of KBN's Joint Decision in a Particular Currency (observing only the first issue in a month of issue)

Estimator	AUD	CHF	NZD	USD
constant	-0.408 (0.189)	-0.909 (0.518)	-1.008 *** (0.155)	-0.482 *** (0.175)
AUD spread	1.057 (0.688)			
CHF spread		-1.405 * (0.902)		
NZD spread			-0.225 (0.478)	
USD spread				0.447 (0.470)
McFadden R-squared	0.021	0.099	0.003	0.007
Number of observations = 1	26	4	15	34
Number of observations = 0	70	92	81	62

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Table 125: Probit of Kommunekredit's Joint Decision in a Particular Currency (observing only the first issue in a month of issue)

Estimator	AUD	CHF	NZD	USD
constant	-0.713 (0.456)	-1.135 (0.222)	-1.530 * (0.564)	-0.802 *** (0.246)
AUD spread	0.508 (0.646)			
CHF spread		-3.006 *** (0.917)		
NZD spread			-0.426 (1.064)	
USD spread				1.377 ** (0.946)
McFadden R-squared	0.008	0.265	0.003	0.034
Number of observations = 1	14	7	9	13
Number of observations = 0	82	89	87	83

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

The univariate conditional decision to issue in one currency

Table 126 toTable 131 present the agency's decision to issue a bond in a given foreign currency, conditional upon issuing a bond in that month. A univariate regression restricts the agency to looking at the 'currency spread' of just one foreign currency relative to its domestic currency.

In a month when a bond is issued in a foreign currency, the 'currency spread' is calculated on the curve date for the respective issue. If there is a month with no issue, the 'currency spread' is calculated as the average of the month-start and month-end values. If there is more than one issue in a month, all observations are included.

The more negative a 'currency spread' is, the more attractive that currency is to issue in relative to the domestic currency. Thus, I look for a negative and significant regression coefficient to indicate that an issuer's decision to issue in that foreign currency is sensitive to that spread.

Table 126: BNG's Conditional Decision to Issue in a Particular Currency

Estimator	AUD	CHF	JPY	NZD	USD
constant	-0.661 (0.425)	-0.707 *** (0.173)	-1.094 *** (0.364)	-0.814 * (0.461)	0.349 (0.327)
AUD spread	-0.661 (0.484)				
CHF spread		-2.635 *** (0.968)			
JPY spread			-3.294 ** (1.368)		
NZD spread				0.234 (0.739)	
USD spread					0.879 (0.739)
Log likelihood	-52.1	-35.3	-9.0	-34.7	-52.0
McFadden R-squared	0.018	0.107	0.287	0.001	0.013
Number of observations = 1	35	16	3	13	38
Number of observations = 0	42	62	72	63	38

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

The negative and significant coefficients on CHF spread and JPY spread indicate that BNG is spread-aware in timing its bond issues in these currencies, albeit the JPY sample is very small. BNG does not consider spreads to time issuance in AUD, NZD or USD.

Table 127: NWB's Conditional Decision to Issue in a Particular Currency

Estimator	AUD	CHF	JPY	NZD	USD
constant	-1.545 *** (0.552)	-0.634 *** (0.194)	-0.738 ** (0.317)	-6.333 * (3.386)	0.230 (0.379)
AUD spread	-0.949 (0.597)				
CHF spread		-4.571 *** (1.239)			
JPY spread			-3.115 *** (1.168)		
NZD spread				-5.132 (3.601)	
USD spread					1.362 (0.905)
Log likelihood	-31.3	-27.2	-13.2	-3.4	-38.7
McFadden R-squared	0.039	0.266	0.230	0.338	0.031
Number of observations = 1	14	17	5	1	23
Number of observations = 0	46	47	55	58	37

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

NWB finds AUD, NZD and USD 'currency spreads' negative most of the time and Table 127 suggests that NWB does not consider spreads to time issuance in these currencies. NWB is 'currency spread' aware when deciding whether or not to issue in CHF and JPY.

Table 128: MuniFin's Conditional Decision to Issue in a Particular Currency

Estimator	AUD	CHF	JPY	NZD	USD
constant	-0.326 (0.486)	-0.794 *** (0.190)	-1.939 *** (0.512)	-0.434 (0.446)	-0.143 (0.324)
AUD spread	-0.342 (0.579)				
CHF spread		-2.792 *** (0.818)			
JPY spread			-0.804 (1.554)		
NZD spread				-0.084 (0.759)	
USD spread					0.451 (0.683)
Log likelihood	-49.0	-28.1	-5.0	-40.8	-40.7
Mcfadden R-squared	0.004	0.201	0.025	0.001	0.005
Number of observations = 1	34	15	1	22	23
Number of observations = 0	37	50	60	41	39

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

MuniFin is spread aware in timing bond issuance in CHF. There is a strong and negative relationship with the CHF 'currency spread'. Otherwise, no relationship between the timing of its decision to issue in other currencies and 'currency spreads' is suggested.

Table 129: Kommuninvest's Conditional Decision to Issue in a Particular Currency

Estimator	AUD	CHF	NZD	USD
constant	-0.330 (0.258)	-0.708 (0.507)	-0.883 *** (0.190)	-0.259 (0.200)
AUD spread	-0.001 (0.687)			
CHF spread		-0.656 (0.655)		
JPY spread				
NZD spread			0.534 (0.641)	
USD spread				1.399 ** (0.578)
Log likelihood	-40.9	-21.0	-28.0	-40.6
McFadden R-squared	0.000	0.024	0.012	0.071
Number of observations = 1	23	7	11	32
Number of observations = 0	39	52	48	31

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

The USD regressor is significant and positive, which is counter-intuitive. Otherwise, there is little to suggest a relationship between the decision to issue in other currencies and 'currency spreads'.

Table 130: KBN's Conditional Decision to Issue in a Particular Currency

Estimator	AUD	CHF	NZD	USD
constant	0.209 (0.201)	0.234 (0.501)	-0.636 *** (0.174)	0.101 (0.206)
AUD spread	1.258 * (0.727)			
CHF spread		-1.881 ** (0.905)		
JPY spread				
NZD spread			-0.679 (0.513)	
USD spread				0.277 (0.506)
Log likelihood	-47.7	-16.3	-34.8	-44.3
McFadden R-squared	0.031	0.163	0.026	0.003
Number of observations = 1	35	6	16	37
Number of observations = 0	36	58	47	28

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

KBN is spread aware in timing bond issuance in CHF. There is a strong and negative relationship between the decision to issue in CHF and the CHF 'currency spread'. The AUD regressor is significant and positive, which is counter-intuitive.

Table 131: Kommunekredit's Conditional Decision to Issue in a Particular Currency

Estimator	AUD	CHF	NZD	USD
constant	0.352 (0.593)	-0.713 *** (0.269)	-1.262 * (0.754)	-0.021 (0.295)
AUD spread	0.944 (0.811)			
CHF spread		-2.747 *** (1.033)		
JPY spread				
NZD spread			-1.038 (1.462)	
USD spread				1.746 * (0.939)
Log likelihood	-27.2	-14.1	-21.1	-23.1
McFadden R-squared	0.025	0.239	0.012	0.083
Number of observations = 1	16	7	9	13
Number of observations = 0	26	33	31	27

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 in a month when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period Jan 2009-Dec 2016

Kommunekredit is spread aware in timing bond issuance in CHF. There is a strong and negative relationship between the decision to issue in CHF and the CHF 'currency spread'. The USD regressor is significant and positive, which is counter-intuitive.

Multivariable conditional decision to issue in one currency

From Tables 132 to 137, I look at the agency's decision to issue a bond in a given foreign currency, conditional upon issuing a bond in that month. The probit regression analyses the decision to issue in a particular currency relative to a vector of 'currency spreads' for five different currencies, which an agency sees simultaneously. For each agency, the months when it does and does not issue are identified. If there is more than one issue in any month, all the observations within that month are included. I do not include marginal effects or linear regressions here, as these essentially replicate the results that are shown within Tables 83 to 106.

In general, there is limited evidence that issuers are spread aware in their currency choice. For BNG, there is evidence of a relationship between the 'currency spreads' and its decision to issue in AUD. The AUD spread coefficient is significant and negative and the NZD and USD spreads are significant and positive. While two regressors are significant in BNG's decision to issue in CHF, the CHF 'currency spread' is not significant and the coefficients of AUD spread and JPY spread are negative. There is little evidence of relationships within the decisions to issue in JPY, NZD, although two regressors are positive in the USD bond issue regression.

Three of the 'currency spread' regressors are significant for NWB's decision to issue in CHF, although the CHF spread is not significant and two of the significant coefficients are negative. Neither of the JPY or NZD regressions produce an output. For MuniFin and KBN, three regressors for the decision to issue in AUD are significant and two of these are positive. However, the AUD 'currency spread' is not significant for either issuer.

In general, the results for MuniFin, Kommuninvest, KBN and Kommunekredit offer limited evidence of a relationship between the decisions to issue in a given currency and 'currency spreads'. Where some results had been significant in the univariate regressions of the decision to issue in CHF, they lose significance in the multivariable analysis.

Table 132: BNG's Decision to Issue in a Particular Currency – Multiple Variables

Estimator	AUD	CHF	JPY	NZD	USD
constant	0.676 (0.665)	1.723 (0.931)	-10.746 (9.361)	-0.893 (0.729)	0.932 (0.646)
AUD spread	-2.859 *** (0.964)	-2.524** (1.184)	22.837 (16.633)	-0.243 (1.078)	1.920 ** (0.890)
CHF spread	-2.434 (1.575)	1.677 (2.179)	-4.234 (7.401)	2.820 (1.933)	2.736 * (1.563)
JPY spread	-1.556 (1.456)	-7.556*** (2.312)	2.527 (12.429)	-1.482 (1.554)	-1.316 (1.234)
NZD spread	1.708 ** (0.829)	2.212** (1.056)	-24.156 (19.343)	0.793 (0.953)	-0.371 (0.767)
USD spread	3.685 ** (1.530)	3.667* (2.019)	-19.779 (15.301)	-1.038 (1.881)	-1.602 (1.401)
Log likelihood	-45.4	-24.7	-4.4	-33.5	-48.1
McFadden R-squared	0.145	0.375	0.650	0.038	0.087
Number of observations	77	78	75	76	76
Number of observations = 1	35	16	3	13	38

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period is January 2009 to December 2016

Table 133: NWB's Decision to Issue in a Particular Currency

Estimator	AUD	CHF	USD
constant	-3.351 ** (1.311)	-1.918 (1.212)	0.804 (0.786)
AUD spread	-0.762 (1.652)	-7.943 ** (3.722)	-0.026 (1.171)
CHF spread	-0.780 (1.665)	-2.189 (3.410)	3.828 ** (1.822)
JPY spread	-0.020 (2.266)	-3.819 * (2.290)	-2.002 (1.646)
NZD spread	-4.757 ** 2.224	7.179 * (3.777)	0.971 (1.099)
USD spread	3.323 (3.146)	2.181 (2.491)	0.391 (1.873)
Log likelihood	-24.9	-16.5	-36.0
McFadden R-squared	0.235	0.554	0.100
Number of observations	60	64	60
Number of observations = 1	14	17	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period is January 2009 to December 2016

Table 134: MuniFin's Decision to Issue in a Particular Currency

Estimator	AUD	CHF	NZD	USD
constant	-0.454 (0.642)	-1.472 * (0.876)	-0.363 (0.719)	-0.735 (0.683)
AUD spread	-0.190 (1.076)	-2.451 ** (1.247)	2.873 ** (1.233)	0.697 (1.090)
CHF spread	-3.179 * (1.819)	0.287 (2.360)	1.451 (1.770)	2.198 (1.788)
JPY spread	3.436 *** (1.228)	-1.687 (1.742)	0.777 (1.231)	-0.207 (1.301)
NZD spread	1.965 ** (0.786)	1.723 * (1.080)	-0.561 (0.864)	-0.853 (0.828)
USD spread	-0.732 (1.411)	0.178 (1.588)	-3.862 ** (1.520)	-1.022 (1.457)
Log likelihood	-40.7	-24.6	-36.9	-38.9
McFadden R-squared	0.171	0.300	0.095	0.049
Number of observations	71	65	63	62
Number of observations = 1	34	15	22	23

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period is January 2009 to December 2016

Table 135: Kommuninvest's Decision to Issue in a Particular Currency

Estimator	AUD	CHF	NZD	USD
constant	0.426 (0.789)	-3.124 * (1.763)	-0.561 (0.930)	-1.333 (0.800)
AUD spread	-1.305 (1.091)	-5.938 * (3.390)	0.760 (1.440)	-0.750 (1.178)
CHF spread	-2.230 * (1.195)	0.592 (2.017)	-0.051 (1.469)	0.646 1.059
JPY spread	0.200 (1.251)	-2.459 (2.163)	1.100 (1.322)	0.309 (1.284)
NZD spread	1.095 (0.837)	9.149 *** (3.528)	1.647 (1.029)	-1.827 ** (0.866)
USD spread	2.364 (1.771)	-3.327 (2.752)	-2.885 (1.864)	2.249 (1.694)
Log likelihood	-38.5	-11.6	-24.0	-37.3
McFadden R-squared	0.058	0.458	0.155	0.145
Number of observations	62	59	59	63
Number of observations = 1	23	7	11	32

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period is January 2009 to December 2016

Table 136: KBN's Decision to Issue in a Particular Currency

Estimator	AUD	NZD	USD
constant	1.078 *	0.035	-0.129
	(0.565)	(0.678)	(0.548)
AUD spread	-0.426	3.097 *	-0.831
	(1.229)	(1.599)	(1.160)
CHF spread	-2.571 ***	-0.062	0.000
	(0.984)	(1.139)	(0.958)
JPY spread	-0.127	0.634	-0.182
	(0.976)	(1.128)	(1.102)
NZD spread	1.618 **	-1.414	-0.165
	(0.769)	(0.911)	(0.766)
USD spread	2.457 *	-1.305	0.958
	(1.431)	(1.647)	(1.514)
Log likelihood	-43.0	-32.0	-43.7
McFadden R-squared	0.125	0.103	0.018
Number of observations	71	63	65
Number of observations = 1	35	16	37

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period is January 2009 to December 2016

Table 137: Kommunekredit's Decision to Issue in a Particular Currency

Estimator	AUD	CHF	NZD	USD
constant	1.006	-0.694	-0.794	-0.267
	(1.081)	(1.513)	(1.343)	(1.105)
AUD spread	-2.016	-0.209	1.175	1.716
	(1.432)	(1.772)	(1.633)	(1.664)
CHF spread	1.372	-5.307	-5.592 *	6.611 **
	(2.180)	(4.056)	(3.288)	(2.728)
JPY spread	-3.586	1.933	2.723	-2.754
	(2.246)	(3.121)	(2.601)	(2.125)
NZD spread	-0.085	1.220	-0.647	-1.178
	(1.523)	(1.948)	(1.825)	(1.523)
USD spread	5.757 **	0.272	-0.328	-0.963
	(2.537)	(2.164)	(1.931)	(2.202)
Log likelihood	-22.4	-13.6	-17.3	-18.8
McFadden R-squared	0.199	0.266	0.187	0.253
Number of observations	42	40	40	40
Number of observations = 1	16	7	9	13

Source: Calculated; robust standard errors key: the dependent variable takes the value 1 when a bond is issued in respective foreign currency, 0 if a month of no issue. Observation period is January 2009 to December 2016

Multinomial probit regressions by issuer

I repeat the exercise of Table 108 in the following tables, dividing the analysis by issuer. Multinomial tables for NWB, MuniFin, Kommuninvest, KBN and Kommunekredit do not include the JPY choice, due to lack of data.

While a number of the spread coefficients are significant across the six sets of regressions, the message in the following tables is not strong:

Table 138: Multinomial Probit of Currency Choice Relative to BNG Home Currency

Currency Mode	Coefficient	Standard Error	P-value
Australian dollar			
c	-0.090	0.658	0.892
Spread AUD	-0.688	0.910	0.450
Spread CHF	-0.410	1.665	0.805
Spread JPY	-0.147	1.408	0.917
Spread NZD	1.451 *	0.853	0.089
Spread USD	-0.189	1.403	0.893
Swiss franc			
c	0.872	0.967	0.367
Spread AUD	-0.872	1.265	0.491
Spread CHF	3.482 *	1.919	0.070
Spread JPY	-5.226 ***	1.827	0.004
Spread NZD	2.550 **	1.155	0.027
Spread USD	-0.190	1.701	0.911
Home	(base outcome)		
Japanese yen			
c	-2.447 **	1.105	0.027
Spread AUD	6.109 **	2.459	0.013
Spread CHF	1.378	3.303	0.677
Spread JPY	0.899	1.753	0.608
Spread NZD	-2.077	2.067	0.315
Spread USD	-7.896 ***	1.620	0.001
New Zealand dollar			
c	-0.770	0.748	0.304
Spread AUD	0.413	1.063	0.697
Spread CHF	3.751 **	1.753	0.032
Spread JPY	-1.409	1.524	0.355
Spread NZD	1.344	0.941	0.154
Spread USD	-2.643 *	1.579	0.094
US dollar			
c	0.350	0.629	0.578
Spread AUD	1.560 *	0.944	0.098
Spread CHF	2.426	1.581	0.125
Spread JPY	-0.591	1.500	0.693
Spread NZD	0.605	0.842	0.473
Spread USD	-2.518 *	1.514	0.096

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for JPY, 4 for NZD and 5 for USD. Observation period is January 2009 to December 2016; observations 161, log likelihood -226.0

Table 139: Multinomial Probit of Currency Choice Relative to NWB Home Currency

Currency Mode	Coefficient	Standard Error	P-value
Australian dollar			
c	-3.286 ***	1.108	0.003
Spread AUD	0.127	1.790	0.943
Spread CHF	0.138	1.966	0.944
Spread NZD	-5.148 **	2.239	0.021
Spread USD	2.487	2.735	0.363
Swiss franc			
c	-1.469	0.899	0.102
Spread AUD	-3.679 ***	1.426	0.010
Spread CHF	-2.099	1.775	0.237
Spread NZD	4.397 ***	1.442	0.002
Spread USD	-0.119	2.090	0.954
Home	(base outcome)		
New Zealand dollar			
c	-15.470 ***	4.035	0.001
Spread AUD	-14.972 ***	5.721	0.009
Spread CHF	-4.602 *	2.598	0.077
Spread NZD	-5.936	5.096	0.244
Spread USD	21.000 **	9.490	0.027
US dollar			
c	0.279	0.845	0.742
Spread AUD	0.748	1.308	0.567
Spread CHF	2.385	1.487	0.109
Spread NZD	0.805	1.457	0.581
Spread USD	-1.012	1.863	0.587

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for NZD and 4 for USD. Observations 87, log likelihood -96.4

Table 140: Multinomial Probit of Currency Choice Relative to MuniFin Home Currency

Currency Mode	Coefficient	Standard Error	P-value
Australian dollar			
c	-0535	0.702	0.447
Spread AUD	-0.616	1.364	0.652
Spread CHF	2.861 **	1.464	0.051
Spread NZD	-0.557	1.001	0.578
Spread USD	-0.215	1.724	0.901
Swiss franc			
c	-1.896 *	0.937	0.043
Spread AUD	-2.507	1.754	0.153
Spread CHF	-0.671	1.612	0.677
Spread NZD	-0.101	1.404	0.943
Spread USD	1.281	1.759	0.467
Home	(base outcome)		
New Zealand dollar			
c	-0.638	0.705	0.366
Spread AUD	1.912	1.373	0.164
Spread CHF	3.495 **	1.598	0.029
Spread NZD	-2.460 ***	0.989	0.013
Spread USD	-1.987	1.759	0.259
US dollar			
c	-1.088	0.685	0.112
Spread AUD	0.318	1.376	0.817
Spread CHF	3.266 **	1.496	0.029
Spread NZD	-2.789 **	1.102	0.011
Spread USD	0.193	1.811	0.915

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for NZD and 4 for USD. Observations 116, log likelihood -164.0

Table 141: Multinomial Probit of Currency Choice Relative to Kommuninvest Home Currency

Currency Mode	Coefficient	Standard Error	P-value
Australian dollar			
c	-0.318	0.760	0.967
Spread AUD	-3.613 ***	1.409	0.010
Spread CHF	-2.049	1.361	0.132
Spread NZD	1.826 *	1.024	0.075
Spread USD	3.069	1.869	0.101
Swiss franc			
c	-3.494	2.257	0.122
Spread AUD	-8.336 *	4.579	0.069
Spread CHF	-0.622	1.581	0.694
Spread NZD	9.420 **	4.486	0.036
Spread USD	-1.932	1.889	0.306
Home	(base outcome)		
New Zealand dollar			
c	-0.444	1.099	0.686
Spread AUD	-2.000	1.752	0.254
Spread CHF	-0.629	1.429	0.660
Spread NZD	3.121 **	1.099	0.005
Spread USD	-0.941	1.914	0.623
US dollar			
c	-1.085	0.706	0.124
Spread AUD	-3.131 **	1.327	0.018
Spread CHF	-0.360	1.351	0.790
Spread NZD	-0.297	1.029	0.773
Spread USD	3.322 *	1.881	0.077

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for NZD and 4 for USD. Observations 98, log likelihood -124.5

Table 142: Multinomial Probit of Currency Choice Relative to KBN Home Currency

Currency Mode	Coefficient	Standard Error	P-value
Australian dollar			
c	0.977	0.586	0.095
Spread AUD	1.913	1.503	0.203
Spread CHF	-0.278	1.229	0.821
Spread NZD	-0.750	0.941	0.426
Spread USD	0.519	1.728	0.764
Swiss franc			
c	-11.076 **	4.820	0.022
Spread AUD	-13.117 **	6.202	0.034
Spread CHF	2.468	2.893	0.394
Spread NZD	20.418 **	8.498	0.016
Spread USD	-9.631 *	5.119	0.060
Home	(base outcome)		
New Zealand dollar			
c	0.430	0.736	0.559
Spread AUD	5.254 ***	1.865	0.005
Spread CHF	1.828	1.328	0.169
Spread NZD	-3.056 ***	0.984	0.002
Spread USD	-2.566	1.864	0.169
US dollar			
c	0.160	0.584	0.784
Spread AUD	2.035	1.652	0.218
Spread CHF	1.623	1.258	0.197
Spread NZD	-1.942 **	0.946	0.040
Spread USD	-0.858	1.735	0.621

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for NZD and 4 for USD. Observations 113, log likelihood -141.4

Table 143: Multinomial Probit of Currency Choice Relative to Kommunekredit Home Currency

Currency Mode	Coefficient	Standard Error	P-value
Australian dollar			
c	1.154	1.186	0.330
Spread AUD	1.088	1.580	0.491
Spread CHF	0.832	1.966	0.672
Spread NZD	0.535	1.949	0.784
Spread USD	-0.228	2.477	0.927
Swiss franc			
c	1.878	1.208	0.120
Spread AUD	2.516	1.770	0.155
Spread CHF	-2.612	2.888	0.366
Spread NZD	2.118	2.595	0.414
Spread USD	-2.883	2.530	0.255
Home	(base outcome)		
New Zealand dollar			
c	1.832	1.255	0.144
Spread AUD	3.334 *	1.900	0.079
Spread CHF	-1.909	2.096	0.362
Spread NZD	0.433	1.857	0.816
Spread USD	-2.982	2.621	0.255
US dollar			
c	0.406	1.199	0.735
Spread AUD	3.426 *	1.753	0.051
Spread CHF	4.482 *	2.398	0.062
Spread NZD	-0.261	2.213	0.906
Spread USD	-4.098	2.975	0.168

Source: Calculated; robust standard errors key: the dependent variable takes the value 0 for home currency, 1 for AUD, 2 for CHF, 3 for NZD and 4 for USD. Observation period is January 2009 to December 2016; observations 55, log likelihood -71.0

I estimate multinomial probit regressions for each issuer that include time fixed effects (not reported), but on each occasion, these fail to converge. Stopping the regressions after 1,000 iterations, these generate very few significant regressors for the variables of interest. This may be due a relatively small number of positive outcomes over the period of review.

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SUMMARY AND CONTRIBUTION OF THE THESIS

The thesis examines the financial innovation of developed market SNGs to raise private funds. It studies aspects of the potential advantage of credit-pooling in SNG bond issuance by comparing three important alternative means for raising long-term municipality debt. Chapter 1 addresses whether direct government-backed lending or funding from credit-pooling agency backed bond issues best suits SNGs. Chapter 2 analyses which of individual bond issues and municipal credit-pooling agency backed bond issues is best suited for US municipalities. Chapter 3 examines the potential interest cost savings from issuing foreign versus domestic currency denominated bonds for MBAs.

My research is motivated by the launch of a new UK municipal credit-pooling agency. If it is to thrive, it must issue bonds at a competitive yield, which will fund long-term loans to local authorities more cheaply than if they were to borrow directly from government-backed agencies, banks or even issue bonds themselves.

Contribution to the literature

I address clear gaps in the existing literature, as I offer policy guidance to the newly created UKMBA. Chapters 1 and 3 focus on the activities of the six largest European MBAs — in the former chapter, there is one just recent European paper (Schnitzler, 2017) of relevance. While there is a literature on the failure of Covered Interest Parity and surveys of high quality bond issuers in different currencies, the closest paper to Chapter 3 focuses on the high quality German bond issuer, KfW (Du et al., 2016). This is the only paper to address European MBA bond issues in foreign currency. The US literature underlying Chapter 2 is far from recent and depends on small survey samples. I create a much larger sample of detailed bond and bond participant data that gives a more accurate input to my empirical work.

The contributions of all three chapters are based on substantial and recent data sets, which I have assembled from available sources. These are discussed in detail within each chapter. The cross currency basis data set of Chapter 3 may have uses for other related work.

Conclusions

In Chapter 1, I show that the bond issues of a counterfactual UK MBA can generate interest cost savings relative to a synthetic Public Works Loan Board (PWLB) bond issuer. That said, the actual UK Municipal Bond Agency (UKMBA) competes against a strong incumbent loans company, which is 100% owned by central government and is the dominant force in the UK market for local authority long-term funding. Recent evidence shows that the PWLB's loan pricing is responsive to competitive pressures from the UKMBA (see below).

In Chapter 2, a municipality's credit rating and required size of long-term funding determine whether to participate in the bond issuance programme of a US MBB. Participation has a significant and negative effect on a municipality's interest costs. However, the interest cost savings seem to be insufficient to convince the larger and better credit-rated municipalities to commit to an MBB bond issue programme, when taking into account the greater flexibility of timing bond issues for individual higher credit-rated municipalities than participating within a pool of bond issues.

In Chapter 3, the failure of Covered Interest Parity (CIP) provides European MBAs with an opportunity to reduce interest costs when timing foreign currency bond issuance. Most of the time, MBAs do take advantage of lapses in CIP. But deviations from CIP rarely influence their timing of decisions to issue bonds in a foreign currency. I find limited evidence that MBA bond issuers use the failure of CIP to optimally time the issuing of foreign currency bonds, with the exception of the Swiss franc.

Implications for the UK Municipal Bond Agency

In October 2019, the UKMBA announced that it was restructuring, in order to readdress the borrowing needs of local authorities. This occurs five years after launching, having attracted a membership that accounted for just 15% of UK local authorities and having failed to issue a single bond. The proposed revised framework eliminates the existing unconditional element of the bonds guarantee, which has proved a stumbling block to many local authorities that may wish to borrow from the agency. Under the proposed new business model, local authorities will guarantee bonds issued by the UKMBA in proportion to their borrowings from it. 'Joint and Proportional' guarantees will incorporate a contributions mechanism, whereby if a local authority in the UKMBA's lending programme falls into financial distress, the guarantee of other borrowers is only proportional to the level of their own borrowings, but the agency can ask all other local authorities on a non-binding basis to provide loans to cover the recovery of the distressed local authority. This differs from the six mature European MBAs, whose respective business models rest upon either a members' joint and several guarantee or implicit government guarantee of their bond issues. Differences in the UK from the collectivist culture of the Dutch and Nordic MBAs seem to hamper local authority buy-in to a business model that has proved successful elsewhere.

A further hurdle for the UKMBA is that it competes directly with a mature and specialist lender. UK local authorities can borrow on demand relatively large sums from the PWLB, the leading provider of funding to local councils by on-lending government borrowing, on terms of up to 50 years at a fixed spread over the par gilt curve. Indeed, most UK local authorities have enjoyed a relationship with the PWLB for many years and there may be an element of anchoring by many of them to this provider. Such competing agencies are not so significant in the European countries where MBAs are active, other than France.

My thesis follows an 'ideal world' counter-factual that a synthetic UK MBA, credit-ranked pari passu with the European MBAs, can issue bonds in public markets and distribute loans to its member local authorities. While I identify modest interest cost savings relative to the PWLB's loan rates in basis points terms, the UK's 515 local authorities had total outstanding borrowings of £97.2 billion for capital investment programmes at September 2018, according to the UK Ministry of Housing, Communities and Local Government. Were a hypothetical 10 basis point saving to be achieved on all current interest costs, this would represent just under £100 million per annum for local authorities in the long run. In the real world, having acquired a credit rating from Moody's that is one notch below that of the UK government, the actual UKMBA must build a rigorous credit process to allow local authorities to take advantage of market interest rates, while being subject to market discipline. To date, only a small number of UK local authorities has been attracted to its business model — structural issues offset potential financial savings.

One consequence within days of the announced restructuring of the UKMBA was a hike of 20 basis points in the 'Certainty Rate' fixed margin to 100 basis points over gilts offered by the Public Works Loan Board to UK local authorities. This body last reduced its margin to 80 basis points in November 2012, just as the UKMBA was taking form. The UKMBA's impact on the interest costs of UK local authority funding to date has been indirect, via its influence over PWLB loan pricing.

Are credit-pooling agencies under-utilised?

MBAs have proved successful in some developed countries. Their excellent long-term records of avoiding credit distress are reflected in strong credit ratings and competitive loan pricing for their member SNGs. However, this business model is active in just a dozen developed markets and it struggles in the UK and North America. Despite a long and successful history in parts of Europe and Japan, the concept of municipal credit-pooling agencies does not have deep roots on a global basis. There are few developed countries where municipal bond agencies or municipal bond banks are active. Evidence from the US and Canada shows that providers of credit to SNGs via municipal bond banks or municipal finance agencies are struggling to make more than a minor contribution to the overall municipal bond market. The UK and US experiences would argue that MBAs and MBBs have yet to convincingly carve a role in public finance in many global environments. Just seven developed countries are supporting thriving municipal bond agencies for long-term SNG finance. Only New Zealand and France have launched significant municipal bond agencies within the last 10 years.

Policy implications

The credit-pooling agency whose bond issues are based on a joint and several guarantee, succeeds in some countries and not in others. MBAs operate through a coinsurance design, whereby financially stronger SNGs subsidise weaker ones. They indirectly leverage on their country's borrowing capacity, so they require supportive institutions including a highly credit-rated national government, a legal system that allows interventions if an SNG falls into financial distress, and prudent borrowing by subnational governments. Most importantly, they require the collective buy-in of a peer group that wishes to use this agency to reduce the cost of borrowing for the common good. The UK is a country, where local authorities are reluctant to provide a joint and several guarantee for their liabilities and therefore the original MBA model fails.